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THE EDUCATIONAL SIGNIFICANCE OF LEFT-HANDEDNESS

BY

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TEACHERS COLLEGE, COLUMBIA UNIVERSITY
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THE EDUCATIONAL SIGNIFICANCE OF LEFT-HANDEDNESS

CHAPTER I

THE PROBLEM

The interest of students in the phenomenon of human handedness is by no means new. A large number of investigations have been carried out with the aim of answering various questions which are raised by the relation of man's hands to each other. A wide variety of attacks have been made on the problem. A correspondingly varied number of conclusions have been arrived at with respect to the many phases of the problem. Indeed, there are few psychological problems for which so large and so conflicting a body of solutions have been offered. Only a small number of the numerous questions which center around the manual relation have received an entirely unanimous answer.

Nature of Previous Studies

The method and conclusions of the present investigation will be clear with only brief reference to earlier studies in the same field. No effort will be made, therefore, to present an exhaustive review of the voluminous literature of handedness. Attention will be called merely to the general methods which have been used in attacking the problem, with representative examples of studies which have used the various methods. Extensive summaries of the earlier literature may be found in studies by Beeley [1] and Jordan. [2]

Explanatory Theories.—The question of the basic cause for the presence in man of a preferred and a non-preferred hand has engaged the attention of a number of students. The answer to this question is fundamental to the study of a number of other phases of the problem.

Behind most of the explanations which have been suggested is to be found one of two general assumptions—either handedness

[1] Beeley, A. L., *Experimental Study in Left-handedness*, Chap. V, pp. 63-67.

[2] Jordan, H. E., "The Inheritance of Left-Handedness," *American Breeders Magazine*, Vol. 2, No. 1 (1911), pp. 19-29; 113-24.

is a native characteristic or it is a habit which is acquired through the experiences of living. As representative of those who consider manual preference to be an inborn trait may be cited Jordan,[3] who, as the result of studying the hand tendencies of 78 families, reached the conclusion that handedness is inherited and perhaps in Mendelian ratio. Other students, such as Watson,[4] find evidence that hand preference is largely determined by the circumstances with which the individual is surrounded when he begins to engage actively in manual operations.

In addition to these two general theories as to the origin of hand preference, a wide variety of other explanations, often variants of these two, have been offered. The simple suggestion was made by Bell[5] in 1833 that a far-sighted Nature decided that man would get on to better advantage if he were right-handed. In contrast, we find explanations, such as that of Meyer,[6] which are based on a complex relation between the cerebral hemispheres and the motor functions of the body. The dominant right hand has been related to the dominant right eye by Gould[7] and others. Social usage has resulted, according to Wilson,[8] in a very large strengthening of the right hand for most individuals. This by no means exhausts the list of explanations but suggests some of the lines along which a cause of hand preference has been sought. The question, it would seem, will finally be answered only by such an accumulation of neurological data as will reveal the exact nature of the relation between the brain and the two hands.

Handedness and General Bodily Symmetry.—That man's bimanual structure is but a part of his general bi-symmetrical make-up is a physiological fact of common observation. The influence of one member of the hand pair on the other and the relation of both to the body as a whole have been attractive matters for investigation. It seems clear, according to Ewert,[9] that the hands are so intimately related that practice with one

[3] Jordan, H. E., *op. cit.*, pp. 122-23.

[4] Watson, J. B., *Behaviorism*, pp. 99-102.

[5] Bell, C., *The Hand, Its Mechanism and Vital Endowment as Evincing Design*, pp. 140-42.

[6] Meyer, M., "Left-handedness and Right-handedness in Infancy," *Psychological Bulletin*, Vol. 10 (1913), pp. 52-53.

[7] Gould, G. M., *Right-handedness and Left-handedness*, pp. 35-37.

[8] Wilson, D., *Left-handedness*, pp. 208-10.

[9] Ewert, P. H., "Bilateral Transfer in Mirror-Drawing," *Pedagogical Seminary*, Vol. 33 (1926), pp. 235-49.

tends to produce a certain degree of change in the other. The extreme bi-symmetrical phenomenon of mirror-writing which occurs only in left-handed children has been explained by Fuller [10] as the physiological result of some weakness or disease. Carmichael [11] has connected mirror-writing with the child's attempt to integrate into larger units the simple movements which have grown up during the "scribble" period of his hand development.

As part of the general bi-symmetrical pattern of the body the types of footedness, eyedness, and earedness have received some attention. Gould [12] has concluded that an individual is either dextroexpert, generally as to ear, eye, hand, and foot, or else he is sinistroexpert. Parsons [13] finds strong evidence of a close relation between the dominant hand and the sighting eye.

Handedness and Speech Defects.—The fact that the majority of the members of the race are right-handed and that most of the physical arrangements of life are planned to suit the needs of right-handed people has led to the belief on the part of many parents and teachers that the left-handed child, ought, for his own advantage, to be made as right-handed as possible. Since handwriting is the manual art which the school most commonly teaches, there has developed a conviction that in this activity, at least, the normally left-handed child ought to be brought into conformity with the majority. Since children usually begin to use the dominant hand for movements of the writing type some time before it is discovered that they are doing so, it becomes necessary in the case of most left-handed individuals to break the habit after it is fairly well formed. The resulting nerve disturbance has been offered by investigators such as Ballard, [14] Blanton, [15] Nice, [16], and Whipple [17] as a potent cause of speech

[10] Fuller, J. K., "The Psychology and Physiology of Mirror-Writing," *University of California Publications in Psychology*, Vol. 2, No. 3 (1916), pp. 199-265.

[11] Lord, E. E., Carmichael, L., and Dearborn, W. F., *Special Disability in Learning to Read and Write*, p. 47.

[12] Gould, G. M., *op. cit.*, pp. 18-20.

[13] Parsons, B. S., *Lefthandedness*, pp. 36-44.

[14] Ballard, P. B., "Sinistrality and Speech," *Journal of Experimental Pedagogy*, Vol. 1 (1911-12), p. 298.

[15] Blanton, M. G. and Blanton, S., "What is the Problem of Stuttering?" *Journal of Abnormal Psychology*, Vol. 13 (1919), pp. 303-13.

[16] Nice, M. M., "The Speech of a Left-Handed Child," *Psychological Clinic*, Vol. 9 (1915), pp. 115-17.

[17] Whipple, G. M., "The Left-Handed Child," *Journal of Educational Psychology*, Vol. 2 (1911), pp. 574-75.

disorders which often occur about the time the writing habit is in process of being modified. Other studies, such as those of Wallin,[18] Lippert,[19] and Fletcher[20] show little relation between speech disturbance and change of hand action. Although a great deal of investigation has been carried on with reference to the causes of speech disorders, the evidence for a close relation between changing the writing hand and such disorders still seems inconclusive.

Classification of Handedness Types.—The terms which are used in popular language to describe the various conditions of handedness consist almost entirely of the familiar "right" and "left." That these terms apply at best only to the extremes of the manual series has been evident to students of the problem for a long time. A recent and promising type of investigation has been initiated by Downey[21] and by Rife,[22] and has consisted of attempts to analyze handedness tendencies into more clear-cut classes and to apply to the classes terms which will have a reasonably delimited meaning. It seems safe to expect, therefore, that in the future we shall be able to speak of the various manual patterns with as much confidence as we now speak of different types of silent reading activities.

Incidence of Handedness Types.—What would appear to be one of the simplest types of studies of the handedness question; namely, the number of each kind of manual preference in the total population, seems to have attracted so few workers that we are still far from sure what percentage of the race does naturally use each hand predominantly. One of the most extensive studies made in America, that of Jones,[23] involving more than 20,000 cases, showed that about 4 per cent of people are left-handed. A survey made by an anonymous writer[24] in England showed that in elementary and secondary school popu-

[18] Wallin, J. E. W., "A Census of Speech Defectives Among 89,057 Public School Pupils," *School and Society*, Vol. 3 (1916), pp. 213-16.

[19] Lippert, E., "A Note on the Sinistrality of Children," *Pedagogical Seminary*, Vol. 21 (1915), p. 485.

[20] Fletcher, J. M., "The Etiology of Stuttering," *Journal of the American Medical Association*, Vol. 66 (1916), pp. 1079-81.

[21] Downey, J. E., "Types of Dextrality and Their Implications," *American Journal of Psychology* Vol. 38 (1927), pp. 317-67.

[22] Rife, J. M., "Types of Dextrality," *Psychological Review*, Vol. 29 (1922) pp. 474-80.

[23] Jones, W. F., *A Study of Handedness*, p. 46.

[24] Anonymous, "Left-Handed Children," *Elementary School Journal*, Vol. 28 (1927), pp. 253-55. (From the *London Times Educational Supplement.*)

lations only 2.7 per cent of the children are left-handed individuals. No doubt the use of well-understood descriptive terms would greatly reduce the apparent discrepancy between the results of these two investigations.

Handedness and Intelligence.—Although the literature contains numerous inferences concerning possible correlation of handedness type with intelligence level, almost no direct effort has yet been made to demonstrate clearly such a connection. The evidence which is available is mainly drawn from studies of defectives and delinquents of various sorts. It has been shown by Doll [25] that among feeble-minded children the strength of grip of the left hand is, on the average, greater than that of the right hand. An extensive study of dependent children in California, made by Gordon, [26] seemed to lead to the conclusion that left-handed children are not inferior mentally to right-handed children. Although further investigation is needed, the results of the second study just cited seem to represent the safer conclusion as to the relation of handedness and intelligence.

Training of the Hands.—The question of the most effective method of training the hands is still largely in the stage of unsupported opinion. The argument for and against ambidexterity has been a long and often acrimonious one. It has produced no guiding principle which the parent or teacher can confidently apply in dealing with the practical problem of teaching children. The final answer must wait, apparently, upon further investigations in neurology.

Problems Considered in the Present Investigation

The present study was organized with two main aims in view: first, to analyze the concept of handedness as it is applied to a specific school population; second, to seek relations between the common forms of hand dominance and such school factors as intelligence, school achievement, interests, emotions, and physical status of children. A subsidiary problem to the two main aims was a study of some of the effects of interfering with natural handedness.

The first aim of the study; namely, the analysis of the general meaning of the term handedness, was undertaken for the pur-

[25] Doll, E. A., *Anthropometry as an Aid to Mental Diagnosis*, pp. 55-58.

[26] Gordon, K., "Some Notes on the Mental Status of the Left-Handed," *Journal of Delinquency*, Vol. 8 (1924), pp. 154-57.

pose of relating, as far as possible, hand behavior to other well-known forms of behavior, especially those commonly dealt with in schools. Is right-handedness, for example, a general term, like silent reading or arithmetical reasoning, which includes a large number of types of activities, differing in the kind and the arrangement of the elements composing them? Similarly, is left-handedness merely a roughly descriptive term which has come into use to designate a considerable number of rather specific behavior patterns?

The second aim of the study—the investigation of the relation of handedness to various practical school questions—was the original problem which prompted the organization of the work and is the main matter upon which the study attempts to throw light. In short, the theoretical interest in handedness was not the primary incentive for making the study, but rather the practical need of bringing handedness, as far as possible, into relation with other matters which are commonly dealt with in schools. Thus such questions as the following were raised: Is there any relation between type of handedness and intelligence? Does handedness have any significant connection with school achievement? Is there any difference between children of different hand tendencies in such matters as interest, school adjustment, and general emotionality? Do children of varying handedness patterns show corresponding differences in general physical make-up?

A second type of practical problem, but differing somewhat from the preceding one, is dealt with in the present study. This turns on the rather old question as to whether natural handedness should be modified by systematic training. The commonest form which such modification takes in school is that of changing the writing of left-handed children to conform to the right-handed procedure. As suggested in the survey of previous studies, such interference has been connected by some workers with speech disturbances and general emotional upsets. An attempt was made in the present investigation to discover any significant differences which seemed to exist between children who had had their natural hand tendencies interfered with and those who had not been so modified. Special attention was given to possible differences in speech condition of the changed and the unchanged left-handed cases.

Summary of the Chapter

The aim of this chapter has been twofold. First, a brief discussion has been given of the general types of investigations which have been carried on concerning the problem of human handedness. Reference has been made to seven main lines along which research has been carried on. In each case an attempt has been made to give a summary statement indicating the point which seems to have been reached by that particular type of study.

Second, a statement has been made concerning the purpose of the present study. It has been emphasized that the aim is primarily practical, rather than theoretical, and that the main interest of the study is in showing to what extent, if any, school procedure needs to take into account variations in handedness type.

CHAPTER II

THE METHOD OF THE STUDY AND THE CHARACTER OF THE GROUP STUDIED

The purpose of this chapter is to describe somewhat in detail the method used in the investigation and to present some general facts as to the character of the group of children which formed the material of the study.

Facilities Required for the Study

The nature of the study called for a fairly large amount of information concerning a rather large group of children. With this in mind, search was made for a school with a considerable number of children in each grade. The need of numbers will be apparent if it is remembered that the proportion of left-handed children to right-handed children is approximately one to fifteen or twenty.

In the second place, there would be an additional advantage in locating a school in which a considerable amount of objective information concerning the children to be studied was either already on file or could be obtained without the expenditure of too much time and energy. Search was therefore made for a school in which data with reference to the intelligence and school achievement of the children to be studied were either at hand or could easily be obtained.

Finally, a school in which space facilities for individual and group testing were readily available seemed of importance if the study was to be carried out within reasonable time limits.

The School Used for the Study

The combination of facilities just discussed was adequately supplied by Public School 210, Brooklyn, New York, and all the data reported in the study were obtained in that school. The school is located in a predominantly Jewish section of Brooklyn. It has an enrollment of approximately 2,700 children. In the

grades used for this study—four to seven inclusive—there were more than 1,100 children. Classification of pupils by the use of intelligence and achievement test results has been an integral part of the administration of this school for a number of years. Consequently, for the majority of children a large amount of data of both of these types was already on file. Information of other sorts was readily obtainable through the coöperation of the teachers of physical training and speech improvement. Finally, the administrative officers of the school put at the disposal of the writer adequate space for individual testing and provided both space and assistance for carrying out the group testing which was necessary.

The Method of the Investigation

General Survey.—The method used in this study was a relatively simple one. A survey was first made of grades four through seven for the purpose of locating the left-handed children. The method used in this survey was to supply each child with a blank which he filled out with certain facts that might form the basis for the selection of the smaller groups to be used in the study. The facts which the child was asked to give were of two sorts: first, routine information, such as name, age, sex; second, general information concerning the hand tendency in three kinds of activities. For the latter material the following questions were asked: *Which hand do you write with? Which hand do you throw with? Which hand do you reach with?* Before the class answered the questions, some drill was given in identifying the two hands by name and a demonstration was given by the writer as to the meaning of the three questions.

In addition to the information obtained from each child about his hand tendencies two items of information concerning each child were obtained from the teacher. The first was a general handedness rating of the child by the teacher and was intended to serve as a rough check on the information given by the child and as a supplement to it. The teacher made the rating by underlining one of the following phrases which were placed on the general survey blank: (a) *mainly right-handed,* (b) *mainly left-handed,* (c) *mixed-handed* (*neither dominant*), (d) *can't classify.*

The second item of information asked from the teacher was

intended to provide a preliminary basis for checking up on speech defects. The teacher was asked to underline one of the following words which in her judgment best described the speech defects of the child: (a) *much,* (b) *some,* (c) *slight,* (d) *none.* If *much* or *some* was underlined space was provided for a brief description of the defect by the teacher. The speech data were also put on the general survey blank.

Preliminary Classification on the Basis of General Survey Information.—After the general survey blanks had been completed by the pupil and the teacher, each blank was marked in terms of the type of handedness which the information seemed to indicate. If the child performed the three activities—writing, throwing, reaching—with the right hand, and if the teacher considered him mainly right-handed, the letter *R* was placed on the upper corner of his blank. If the information on the blank indicated that he did most activities with the left hand the letter *L* was placed in the upper corner of his blank. If the child was apparently left-handed with the exception of his writing, the mark *L–* was placed on the blank. If he seemed to do most but not all activities with the right hand he was designated with the mark *R–*. Thus the children were divided into four rough classes: pure right-hands, marked *R*; pure left-hands, marked *L*; changed left-hands, marked *L–*; and mixed-hands, marked *R–*. The last group was not dealt with in detail in this investigation.

Groups Selected for Intensive Study.—All blanks marked *L* were next grouped together and constitute what is referred to in the remainder of this report as the "unchanged" left-handed group; i. e., their natural handedness had not been interfered with. The blanks marked *L–* were grouped together and constitute what is referred to as the "changed" left-handed group, i. e., their writing hand had been changed from left to right. These two groups combined make up the total left-handed group.

As a control group with which to compare this left-handed group, a group of children was selected from those marked *R* in the preliminary classification. For each left-handed child a right-handed mate was found of the same chronological age, sex, and school grade. The pairs of children thus formed constitute the group which was studied in detail, and the data concerning them make up the basic material of the investigation.

Types of Data Obtained for Each Pair Studied.—Each member

of the two groups was given a series of handedness tests to determine the constitution of his manual pattern. Each member of the two groups was given an individual test for speech condition. Each member was weighed and was measured for height and for strength of grip. The entire group was tested as a group for intelligence, school achievement, general and school interests, school adjustment, and general emotionality. Details concerning the method employed in obtaining each of these types of information will be discussed in the chapters dealing with each kind of data.

General Character of the Group Studied

Grade and Sex Distribution.—The distribution of the left- and right-handed groups in the four grades from which children were drawn is shown in Table 1. Although the seventh grade

TABLE 1

Grade and Sex Distribution of Left-Handed Group and Right-Handed Mates Composing the 68 Pairs Used in the Study

Grade	Left-Handed Group			Right-Handed Group		
	Boys	Girls	Total	Boys	Girls	Total
Fourth	12	5	17	12	5	17
Fifth	7	9	16	7	9	16
Sixth	5	6	11	5	6	11
Seventh	11	13	24	11	13	24
Total	35	33	68	35	33	68
Per cent of total	51.5%	48.5%	100.0%	51.5%	48.5%	100.0%

shows the largest number of left-handed cases, the differences between the four grades taken as a whole are too small to have any significance. The totals for the two groups mean, of course, that 68 pairs of children, each pair consisting of a left-handed and a right-handed child, composed the group used in the study.

Comparison of the sexes within the grades shows a rather large numerical superiority of boys over girls in the fourth grade, with

only small differences in the three higher grades. The number of boys in the two groups exceeds slightly the number of girls.

Age Status.—As described in the preceding section, the pairs used in the study were made up on the basis of sex, chronological age, and school grade. It was felt that keeping these three factors constant would make possible a somewhat more clear-cut view of any differences which might appear between the left-handed and the right-handed group in such variables as intelligence and school achievement.

At the same time the question may be fairly raised as to whether keeping school grade constant does not introduce the possibility of obtaining a group of right-handed children which is not representative in age of the entire right-handed population. In short, is the right-handed group used in the study (and of course the left-handed group as well) an "at age" group, an "overage" group or an "underage" group?

In order to deal with this problem, Table 2 was arranged. The table compares the age in months, grade by grade, of the left-handed group, the right-handed group, and the total school population from which children were drawn, i. e., all of the children in grades four to seven. The means for the three groups are almost identical for the fourth grade. For the fifth grade both of the

TABLE 2

AGE IN MONTHS OF LEFT-HANDED GROUP, RIGHT-HANDED GROUP, AND TOTAL POPULATION SAMPLED

Grade	Mean			S. D.		
	Left-Handed Group	Right-Handed Group	Total Population	Left-Handed Group	Right-Handed Group	Total Population
Fourth	114.17	114.18	114.38	6.84	6.84	9.31
Fifth	130.5	129.75	125.57	6.18	6.96	10.8
Sixth	137.72	137.72	140.72	8.22	8.22	13.86
Seventh	150.0	150.0	149.64	11.58	11.46	12.72
Total	134.46	134.38	132.91	16.5	16.56	17.87
P. E.	1.35	1.37	.36			

groups studied—left-handed group and right-handed group—are somewhat older than the population as a whole. The sixth grade groups studied are somewhat younger than the population as a whole. The seventh grade groups, like the fourth grade groups, are almost identical in age. The total means show that the two groups used in this study are somewhat more than one month older than the total population from which they were drawn. At the same time the probable errors of the total means for the two smaller groups are large enough to offset even this small difference.

Table 2 gives also the deviations within the ages of the three groups. The total population is more variable for each grade than are the two smaller groups. The total variation within the three groups is, however, almost identical. Summarizing the data presented in Table 2, it seems safe to conclude that the groups used in this study—both the left-handed and the right-handed groups—are as typical of the age of the entire population from which they were drawn as groups of that size could be expected to be.

Summary of the Chapter

The general procedure used in the study has been outlined. This has consisted of three steps: a general survey of the handedness status of a large elementary school population, the selection of a small group for intensive study, the gathering of various data concerning this small group.

The grade and sex distributions of the 68 pairs of children used in the study have been presented. It has been shown that these pairs are typical in age-grade status of the total population from which they were drawn.

CHAPTER III

THE MEANING OF THE CONCEPT OF HANDEDNESS

The present chapter attempts to do two things: first, to present an analysis of the meaning of the term handedness as revealed by a set of tests which were applied to the group being studied; second, to present data bearing on the incidence of various broad handedness types in the school population which was sampled.

Nature of the Handedness Tests

A variety of tests of a technical character has been employed in the past for the purpose of detecting and analyzing differences in hand tendencies. Among the well-known laboratory methods which have been applied to the problem are the following: rate of tapping with each hand, steadiness of each hand, tracing, aiming. Jones[1] made use of a measuring device known as a brachiometer, by means of which the comparative length of the arm bones and the comparative size of the arm muscles could be combined to produce an index of manual preference or non-preference. Parsons[2] devised an apparatus known as the manuscope by means of which the visual line which is naturally used in sighting becomes an index to hand preference.

For purposes of the present investigation, however, it seemed more promising to use tests of a less formal character but more typical of common kinds of hand behavior. It was felt that a combination of a sufficient number of such informal tests might be more representative of hand activities as they appear in school than the more rigid laboratory activities.

The set of tests which was finally used for the analysis of handedness consisted of the following eight types of activities:

1. *The direction of movement of the hand in drawing a figure on paper.* The purpose of this test was to obtain some measure

[1] Jones, W. F., *A Study of Handedness*, p. 6.
[2] Parsons, B. S., *Lefthandedness*, Chap. VII.

of the strength of the general bisymmetrical tendency in the two hands.

2. *Throwing an object with one hand.* This activity seemed typical of a very large number of the common forms of hand behavior, especially among children.

3. *Receiving an object.* Behavior of this type appears in a large number of hand activities, especially in those of a social character.

4. *Easy reaching.* This activity, like throwing, seems characteristic of a very large number of movements, both of the play variety and of the more serious type.

5. *Energetic reaching.* This activity is, obviously, a variation of the preceding and was introduced to provide an additional measure of a common form of behavior.

6. *Thumb placed on top when hands are clasped.* This common form of hand behavior has often been suggested as an indication of preference.

7. *Use of a baseball bat.* This activity is typical of a number of forms of bi-manual behavior involving the use of large instruments. This test was used by Rife.[3]

8. *Use of a broom.* This activity, like the preceding, is a bimanual form of behavior, but differs from the preceding in the type of pressure exerted on the instrument by the two hands. It has been used as a test of handedness by Downey[4] and by Rife.[5]

Administration of the Tests

The series of tests was administered to each child individually by the writer during a single period of about fifteen minutes. The time varied somewhat from child to child, depending upon the number of trials which were needed to produce a clear tendency for each test.

With the exception of the first test, the entire series was gone through twice and additional trials were made in the case of tests for which a clear record was not produced by two performances. A hand tendency was considered clearly shown if the first two trials were performed by the same hand or if the majority of the trials was performed by the same hand. In only a

[3] Rife, J. M., "Types of Dextrality," *Psychological Review*, Vol. 29 (1922), pp. 474-80.
[4] Downey, J. E., "Types of Dextrality and Their Implications," *American Journal of Psychology*, Vol. 38 (1927), 317-67.
[5] Rife, J. M., *op. cit.*

few cases were more than three trials needed to produce a clear-cut tendency. A record of the hand used for each trial made was kept and will be referred to later.

For the test on direction of movement the child was given a piece of paper and told to draw a horse, first with the dominant hand and then on the reverse side of the paper with the minor hand. The time consumed by each hand in the operation was recorded. The child was credited with the use of the hand in the normal bisymmetrical fashion if the horse faced the left as drawn with the right hand and faced the right as drawn with the left hand.

For the throwing test the child was told to take a soft rubber ball from the table and throw it toward a closed door in the examining room.

For the receiving test the child took a position about two feet from the examiner and was told to take the ball which the examiner handed to him. Occasionally one of the younger children would extend both hands, in which case the trial was repeated with the direction to use only one hand.

For the test of easy reaching the child stood at one end of a table about five feet long and took a small box which had been placed in the middle of the table. For the second trial he stood at the opposite end of the table.

For the test of energetic reaching the child stood at the end of the table and took a small box which was about three-fourths of the length of the table from him. This distance was varied to suit the size of the child being tested. In every case, however, stretching was necessary to obtain the box. In the case of two or three large boys with especially long arms the box was placed on the top of a cupboard which was about twenty inches above their heads. This was done whenever the table test did not seem to require any serious expenditure of energy in the reaching.

For the test of the dominant thumb the pupil was asked to fold his hands. A record was then made as to which thumb was placed on top. A third trial was rarely needed for this test.

For the batting test the child was told to go to the middle of the room and to hold a bat (a regulation-size indoor baseball bat) as he would if the examiner were to pitch a ball to him. The examiner held the ball and went through the motion of pitching. Most of the boys "offered" at the ball in a very realis-

tic manner. The hand was considered dominant which was nearest the batting end of the instrument. This method of scoring is the one used by Rife.[6]

For the sweeping test the child was told to take the broom (a regulation-size kitchen broom), go to the middle of the room, and sweep toward the examiner. The hand was considered dominant which was near the sweeping end. This, again, is Rife's method of scoring.

Composition of Hand Dominance

In order to discover the relation of each of these test activities to the dominant hand, a tabulation was made of the number of children of the left-handed group and of the right-handed group who performed each test with the preferred hand. The percentages were also computed for the total number of children in each group, who performed each test with the dominant hand. Both of these types of data are presented in Table 3. The table means that 18 members of the left-handed group, or 26.5 per cent of that group, performed the direction of movement test from right to left with the left hand; that 53 members of the right-handed group, or 77.9 per cent of that group, performed the same test from left to right with the right hand.

In the first test—direction of movement—more than three fourths of the right-handed group used the dominant hand according to the bisymmetrical pattern, i. e., from left to right, or from the body outward. In the case of the left-handed group only slightly more than one-fourth use the dominant hand in this way. Apparently the change in handwriting which more than two-thirds of the left-handed group had undergone produced a modification of the general bisymmetrical pattern in the direction of right-handedness. If this explanation is sound, we must conclude that change in one type of manual activity has definite effects on other manual activities.

In the remaining four uni-manual tests—throwing, receiving, easy reaching, and energetic reaching—the left-handed group shows a superiority of exactly 3 per cent in throwing, receiving, and easy reaching. In energetic reaching the left-handed group is nearly 6 per cent inferior to the right-handed group. The uni-manual activities thus appear to make a somewhat larger

[6] Rife, J. M., *op. cit.*

TABLE 3

NUMBER AND PERCENTAGE OF LEFT-HANDED AND RIGHT-HANDED GROUPS WHO PERFORMED EACH HANDEDNESS TEST WITH THE DOMINANT HAND

Test	Left-Handed Group		Right-Handed Group	
	No.	Per Cent	No.	Per Cent
1. Direction of movement ..	18	26.5	53	77.9
2. Throwing	63	92.7	61	89.7
3. Receiving	49	72.1	47	69.1
4. Easy reaching	56	82.4	54	79.4
5. Energetic reach	51	75.0	55	80.9
6. Thumb up	44	64.7	36	52.9
7. Batting	41	60.3	47	69.1
8. Sweeping	20	29.4	24	35.3

contribution to the composition of hand dominance of the left-handed group than of the right-handed group.

In the bi-manual activities—clasping, batting, and sweeping—the left-handed group exhibits a rather large superiority over the right-handed group in the tendency to place the thumb of the dominant hand on top in clasping the hands. In the case of batting and sweeping the right-handed group shows some superiority over the left-handed group in the tendency to place the preferred hand in the dominant position on the tool.

In summarizing the differences between the two groups, it may be said that the left-handed group tends to show a superiority over the right-handed group in the less strenuous hand activities—throwing, receiving, easy reaching—while they are inferior to the right-handed group in the activities requiring more expenditure of effort—energetic reaching, batting, and sweeping. The physical correlates of these facts will appear in a later chapter.

Attention may next be called to the dominance of the various activities within the two groups taken as a unit. It will be seen that four activities—throwing, receiving, easy reaching, and energetic reaching—show the highest dominance for the entire group. Thus, if one can observe the throwing activity of an individual, he can obtain an index to dominant handedness which

is correct in about nine cases out of ten for both left- and right-handed people. Easy reaching would be a correct index in eight cases out of ten, receiving in seven cases out of ten, and energetic reaching in seven to eight cases out of ten.

The bi-manual activities are somewhat less significant as indices of handedness. Sweeping is especially low for both groups. Batting does not average for the two groups much higher than the thumb which is uppermost in clasping. It would appear that using the hands in coöperation introduces complicating factors which tend to reduce somewhat the dominant place of the preferred hand in the manual relation.

Total Hand Dominance

In order to obtain some objective measure of the total hand dominance of each individual and of the left- and right-handed groups, a score was given to each of the tests which was used in the analysis of handedness. The following scale was devised for evaluating the tests: a score of 2 for each test in which the dominant hand was used without exception; a score of 1 in which the dominant hand was used in the majority of cases, but in which the minor hand was used in one or more trials; a score of ½ for each test in which the dominant hand was used one or more times but not the majority of times. A perfect score on the eight tests is sixteen. Each individual in each of the two groups of children being compared was given a handedness score based on this scale.

The frequency of scores and the percentage of each score for the left-handed group and for the right-handed group form the data of Table 4. The table, reading from left to right, means that a score of 16 includes 100 per cent of the tests, that three left-handed individuals, or 4.41 per cent of the left-handed group made such a score, that the same number and percentage of right-handed individuals made such a score. The alternating large and small frequencies and percentages is obviously due to the rough scale which was used for scoring the tests.

The median scores and the semi-interquartile ranges for the two groups are given at the bottom of Table 4. The difference between the medians is small and is in favor of the right-handed group. The difference between the ranges is insignificantly small and is also in favor of the right-handed group. The right-

handed group, therefore, seems, according to the tests used here, to be slightly more dominant in the use of the preferred hand than is the left-handed group.

There is a wide range in the scores made by both the left-handed group and the right-handed group. The scores for the

TABLE 4

VARIATION IN DEGREE OF TOTAL HAND DOMINANCE OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES

Score		Left-Handed Group		Right-Handed Group	
Size	Per Cent	No.	Per Cent	No.	Per Cent
16	100.0	3	4.41	3	4.41
15	93.7	1	1.47	3	4.41
14	87.5	9	13.24	16	23.53
13	81.2	1	1.47	5	7.35
12	75.0	15	22.06	14	20.59
11	68.7	4	5.88	5	7.35
10	62.5	15	22.06	11	16.18
9	56.2	4	5.88	3	4.41
8	50.0	10	14.71	5	7.35
7	43.7	1	1.47	2	2.94
6	37.5	2	2.94	1	1.47
5	31.2	1	1.47	0	.0
4	25.0	0	.0	0	.0
3	18.7	0	.0	0	.0
2	12.5	2	2.94	0	.0
Total		68	100.0	68	100.0
Median score		10.43		12.0	
Q of score		1.78		1.88	

left-handed group vary from 2 to 16 or from 12.5 per cent of the tests to 100 per cent. The scores for the right-handed group show a somewhat smaller range: from 6 to 16, with a percentage range from 37.5 to 100 per cent. The range of the left-handed group is increased considerably by the inclusion of the two cases which made total scores of 2 on the tests. Designation of them as left-handed cases at all is, of course, debatable. The writer

took some pains to interview these two children, both of whom were girls. One belonged to the "changed" group, the other to the "unchanged." Both wrote with the left hand and insisted, further, that they did almost everything in school and at home with the left hand. The cases were finally included as evidence of the very wide variation in meaning which such a term as "left-hand" carries.

For the purpose of making generalizations with reference to the data of Table 4, a somewhat simpler table, Table 5, was made up. It represents the percentage of each of the two handedness groups that made scores within the quartiles of the tests. Thus, reading from left to right, the table means that

TABLE 5

PERCENTAGE OF LEFT-HANDED GROUP AND RIGHT-HANDED GROUP WHO MADE SCORES WITHIN EACH QUARTILE OF THE TESTS

Score		Percentage of Group	
Quartile	Scores Included	Left-Handed	Right-Handed
75–100	12–16	42.65	60.29
50–74	8–11	48.53	35.29
25–49	4–7	5.88	4.41
0–24	0–3	2.94	.0

within 75 to 100 per cent of the total number of tests, which included the scores from 12 to 16 inclusive, there were 42.65 per cent of the left-handed group and 60.29 per cent of the right-handed group. The table shows that considerably fewer than one-half of the left-handed group passed three-fourths or more of the handedness tests. About 60 per cent of the right-handed group passed the same proportion of the tests. Almost one-half of the left-handed group passed from only one-half to three-fourths of the tests, and slightly more than one-third of the right-handed group passed the same proportion of the tests. Nearly 9 per cent of the left-handed group and more than 4 per cent of the right-handed group passed fewer than a fourth of the tests.

Individual Variations in Hand Pattern

The extent of variation in hand behavior may be seen more concretely by an examination and comparison of a few individual hand patterns. The following cases were chosen at random from the left- and right-handed groups. For each individual the score which was made on each of the handedness tests is indicated:

Test	*Case 1* Left-Handed Boy	*Case 2* Left-Handed Girl	*Case 3* Left-Handed Boy	*Case 4* Right-Handed Girl	*Case 5* Right-Handed Boy	*Case 6* Right-Handed Girl
Direction of movement	2	0	2	2	0	0
Throwing	2	2	2	2	2	2
Receiving	2	2	.5	1	1	2
Easy reaching	2	2	.5	2	1	2
Energetic reaching	1	2	1	2	2	2
Thumb up	2	0	2	0	0	2
Batting	2	2	2	0	2	.5
Sweeping	0	2	2	0	2	0
Total score	13	12	12	9	10	10.5

It will be seen that the three left-handed cases have only two scores in common—those for throwing and for batting. The activities which compose the total score vary rather widely for the three individuals. The same general statement applies to the three right-handed cases. Again, the same score is made on only two of the tests—throwing and energetic reaching. Individuals to whom the same general hand description is applied tend to show fairly wide variations in the particular combination of elements which make up their hand pattern. One deals, apparently, not with a left-handed type and a right-handed type but rather with left-handed types and right-handed types. The explanation for this very wide range in the composition of hand behavior is probably to be found in two sets of facts. First, individuals differ in physical inheritance sufficiently to produce some variations in responses to situations calling for hand behavior. Second, the conditions under which manual

habits have been developed have doubtless been of such variety that the experiences of any one individual have been somewhat unique as compared with those of others.

The material on hand dominance may be briefly summarized. It appears that there are a few large types of activities, such as throwing, receiving, reaching, which tend to form the general basis of the dominant handedness pattern. With this small group of manual activities as a foundation it seems possible to build up a very wide variety of patterns which exhibit large differences in the degree to which they depart from the hand preference which characterizes the core activities. In short, "left-handedness" and "right-handedness" are by no means unitary terms but may include, on the contrary, combinations of hand activities which differ almost as widely as do the two terms themselves.

Incidence of Handedness Types

It will be remembered that on the basis of the general information on handedness which was obtained as the first step in the study, a rough classification was made of all of the children in the grades from which left-handed children were later drawn. The entire group was divided into four classes: pure right-hands (designated *R*), pure left-hands (designated *L*), changed left-hands (designated *L*–), and mixed right-hands (designated *R*–). The pure left-handed cases and the changed left-handed cases have been dealt with as a group up to this point and the mixed group has not been studied in detail.

For the purpose of indicating the number of cases of each type of handedness in all the grades from which children were drawn, the general classification just referred to will be made use of, except that all the left-handed cases have been grouped together and a small group of doubtful cases has been listed. The data for all children in grades four to seven are presented in Table 6. The table means that there were 106 right-handed boys in the fourth grade, 12 left-handed boys, 5 mixed-handed boys, and 1 of doubtful hand status. The total number of boys in that grade is 124.

Comparison of the size of the various handedness groups can be most easily made by reference to the percentages given in the table. The percentage of right-handedness in the two sexes

TABLE 6

NUMBER OF CHILDREN OF EACH SEX AND PERCENTAGE OF CHILDREN OF EACH TYPE OF HAND STATUS IN GRADES FOUR THROUGH SEVEN

Sex	Grade	Hand Status				
		Pure Right	Pure Left	Mixed	Doubtful	Total
Boy	4	106	12	5	1	124
	5	155	9	8	1	173
	6	108	5	7	1	121
	7	125	12	7	0	144
	Total	494	38	27	3	562
	Per cent	87.9	6.7	4.8	.05	100.0
Girl	4	115	5	6	0	126
	5	149	10	10	0	169
	6	114	7	1	0	122
	7	139	13	13	0	165
	Total	517	35	30	0	582
	Per cent	88.8	6.0	5.1	.0	100.0
Both	Total	1011	73	57	3	1144
	Per cent	88.3	6.3	4.9	.02	100.0

shows a slight difference in favor of the girls. The percentage of left-handed boys in the total population is slightly greater than that of the girls. In mixed-handedness the girls are slightly superior to the boys in percentage.

The percentages for both boys and girls show that in this total population more than 88 per cent of the children are right-handed, more than 6 per cent are left-handed, almost 5 per cent are mixed-handed, and a small fraction of 1 per cent are of doubtful status. The percentage of left-handed children in this population, 6.3, is to be compared with the 4 per cent reported by Jones [7] and the 2.7 reported by an anonymous English investigator. [8] Both of the latter investigations were based on a very

[7] Jones, W. F., *A Study of Handedness.*

[8] Anonymous, "Left-Handed Children," *Elementary School Journal,* Vol. 28 (1927), pp. 253-55. (From the *London Times Educational Supplement.*)

much larger number of children than was the present study. Jones' classification was based entirely on the results of measuring the length of the arm bones and the size of the arm muscles. The classification of left-handedness of the present investigation was based on manual activities. This radical difference in the two methods doubtless accounts for some of the fairly large difference in percentages. The method of classification used in the English study is not reported definitely enough to make comparisons possible.

Summary of the Chapter

Hand dominance seems to consist of a small number of basic activities which are common to most individuals who exhibit a particular preference, plus a wide variety of combinations of minor activies.

Hand dominance may vary in degree from practically one hundred per cent preference to such a low type of strength that clear differentiation from the non-preferred hand is difficult.

This investigation shows a somewhat higher incidence of left-handedness in the total population dealt with than was the case in previous investigations.

CHAPTER IV

HANDEDNESS AND INTELLIGENCE

Statements are frequently found in the literature of handedness which infer that there may be some relation between the type of manual behavior which an individual employs and his native intelligence. This chapter consists of a presentation of the method used for canvassing this phase of the handedness problem as it applies to the group being investigated, together with the results obtained.

Method of Testing

It was mentioned in an earlier chapter that one of the facilities offered in the school in which the investigation was made was a large amount of recorded data on the intelligence and achievement of the children who were studied. With the exception of a small number of children who had recently entered the school, there was information on file concerning the mental status of each child. The amount of information ranged from the results of one group test to the results of four.

Because of the range of grades included in the study—four through seven—the tests which had been given the children ranged from those used in the primary grades to those used in the upper grades. The following is the list of tests which had been applied to some group among the children studied:

Detroit First Grade, Intelligence Test
Otis Group Intelligence Scale, Primary Examination, Form A
Otis Group Intelligence Scale, Primary Examination, Form B
Haggerty Intelligence Examination, Delta 1
Haggerty Intelligence Examination, Delta 2
National Intelligence Tests, Scale A, Form 1
National Intelligence Tests, Scale A, Form 2
National Intelligence Tests, Scale A, Form 3
Otis Group Intelligence Scale, Advanced Examination, Form A
Otis Group Intelligence Scale, Advanced Examination, Form B

The record for each test consisted of the date of administration, the name of the test, the raw score, the chronological age of the child on the date of testing, the mental age of the child as revealed by the test, and the I. Q. resulting from the combination of the chronological and mental ages.

It was decided to obtain the results from three group tests as the basis for the final I. Q. of each child. The complete mental test record on file for each child at the school was first transcribed to an individual record sheet. The sheets for each pair of children—a left-handed child and his right-handed mate —were then placed together and the test records were compared. A check mark was placed on each sheet in front of each test common to the two sheets. The names of the tests which were necessary to complete the record and make the test data identical for both members of the pair were added to each sheet. The additional testing which was needed to carry out this plan was then done by the writer.

After the completion of this supplementary testing, the record of each child contained I. Q.'s obtained from three group examinations. These three I. Q.'s were averaged for each individual and this measure became the final I. Q. on which the comparisons for the two handedness groups were based.

Intelligence in Relation to Handedness

The following constants were next computed on the basis of this material: the mean, probable error of the mean, standard deviation, coefficient of variation for the left-handed group and for the right-handed group; the difference of the means and the probable error of this difference. These data are presented in Table 7. It will be seen that the mean I. Q.'s of the two groups differ by only 1.04 point and that the P. E. of this difference is 1.76, which makes the difference entirely unreliable. The P. E.'s for the two means are both small—1.23 for the left-handed group and 1.26 for the right-handed group. Even with these small P. E.'s the two means have a considerable area of overlapping, since the mean for the left-handed group has a 50-50 chance of ranging from 109.29 to 111.75 in another sample from the same population, and the mean of the right-handed group has the same chance of ranging from 108.22 to 110.74 in another sample. It may be said, then, that there is no reliable

TABLE 7

COMPARISON OF THE INTELLIGENCE QUOTIENTS OF THE LEFT-HANDED GROUP AND OF THE RIGHT-HANDED GROUP

Measure	Left-Handed Group	Right-Handed Group	Difference
Mean	110.52	109.48	1.04 ± 1.76
S.D.	15.1	15.4	.30
V.	13.52	14.07	.55
$P.E._{mean}$	1.23	1.26	

difference between the I. Q.'s of these two groups of children—one of whom is left-handed and the other right-handed.

In the remaining constants which were computed for the two groups with reference to the intelligence test material, the difference in variation within the two groups is very slight. Again, when the mean and the standard deviation are brought together in the coefficient of variation, V., there is only the slightest difference in the constants for the two groups. Apparently there is no difference between these two handedness groups in variability of intelligence.

SUMMARY OF THE CHAPTER

A description has been given of the method used to combine I. Q.'s from group intelligence tests for the purpose of obtaining comparable scores for the two handedness groups.

On the basis of the tests used to measure intelligence there is found no reliable difference between the left-handed group and the right-handed group in mean I. Q., in standard deviation of I. Q., or in coefficient of variation of I. Q.

CHAPTER V

HANDEDNESS AND SCHOOL ACHIEVEMENT

One of the most important practical issues in the entire problem of the educational significance of handedness is, it would appear, the relation of manual preference to achievement in the various school subjects. It is the function of this chapter to present and interpret a body of data bearing on that question.

Method of Testing

The school in which the study was made makes regular use of the Stanford Achievement Test for classification purposes. The recorded data, however, consist of the final total score and the final total subject age for all of the individual tests combined. As it seemed highly desirable that for purposes of this investigation the specific subjects should be taken into consideration, it was decided to retest the entire group. The Stanford Achievement Test, Advanced Examination, Form A, was, accordingly, administered to the left-handed group and to the right-handed group. The test had not been used with any of the children more recently than six months prior to the time it was given by the writer, and in the majority of cases it had not been used more recently than a year and a half prior to this time.

The examination was administered by the writer to groups consisting of about forty-five children each. In making up these groups for testing no attention was paid to handedness differences. In order to care for those who were absent during the regular testing, it was necessary to examine a number of small groups of three or four children each. In all cases the test was given in three sittings according to the schedule outlined by the authors of the test.

On the basis of the raw scores for each individual test, subject ages were computed for each child for the twelve scores which the test as a whole produces: paragraph meaning, sentence meaning, word meaning, total reading, arithmetic computation,

arithmetic reasoning, total arithmetic, nature study and science, history and literature, language usage, dictation exercise (spelling), and composite score.

On the basis of these subject ages the following statistical constants were computed: the mean subject ages of the left-handed group and of the right-handed group in each of the various subjects; the differences between the subject ages for each subject for the two groups with the reliability of those differences; the deviation of subject age within each of the two groups for each subject; the coefficients of variation for each group in each subject.

Handedness in Relation to School Achievement

The constants which resulted from these computations are presented in Table 8. The table means that in paragraph meaning the left-handed group made a mean subject age of 151.54 months, the right-handed group a mean subject age of 156.44 months; that there was a difference of 4.9 between these two mean scores; and the probable error of this difference was 3.25. The meaning of the figures under the columns for standard deviation and coefficient of variation follow in a similar way.

Only three of the ages—those for paragraph meaning, arith-

TABLE 8

Subject Ages in Months for Left-Handed Group and Right-Handed Mates in Various School Subjects

Subject	Mean				S.D.			V.		
	Left	Right	Diff.	P.E. Diff.	Left	Right	Diff.	Left	Right	Diff.
Paragraph Meaning	151.54	156.44	4.90	3.25	28.92	27.36	1.56	19.08	17.49	1.59
Sentence Meaning	152.46	150.79	1.67	3.34	31.4	26.16	5.24	20.59	17.34	3.25
Word Meaning	158.72	159.34	.62	2.73	25.32	21.54	3.78	15.95	13.52	2.43
Total Reading	154.18	155.20	1.02	2.75	24.48	23.22	1.26	15.88	14.96	.92
Arithmetic Computation	158.09	157.76	.33	2.90	24.60	25.38	.78	15.56	16.09	.53
Arithmetic Reasoning	158.27	154.41	3.86	2.86	25.80	23.22	2.58	16.30	15.04	1.26
Total Arithmetic	158.18	155.65	2.53	2.74	23.82	23.52	.30	15.01	15.11	.10
Science	142.09	141.61	.48	2.48	23.40	18.96	4.44	16.47	13.39	3.08
History—Literature	162.36	160.84	1.52	3.42	29.40	29.34	.06	18.11	18.24	.13
Language	153.00	154.32	1.32	3.40	31.44	26.70	4.74	20.55	17.30	3.25
Spelling	153.74	154.38	.64	3.26	23.58	23.22	.36	15.34	15.04	.30
All subjects	153.72	154.05	.33	2.55	23.46	20.28	3.18	15.26	13.16	2.10

metic reasoning, and total arithmetic score—show a difference for the handedness groups of more than two months. The differences in the means for four of the subject ages—sentence meaning, total reading, history-literature, language—are between one and two months. For five of the subject ages—word meaning, arithmetic computation, science, spelling and all the subjects combined—the differences are less than one month. Only two of the differences are larger than their probable errors, and of these only one—that for paragraph meaning—has even a suggestion of being significant, being considerably less than twice its probable error. When all the subjects are combined, one of the two smallest differences in the means for the entire group of subject ages is produced. It may be concluded, then, that on the basis of the tests used, there are no significant differences in achievement in the various school subjects between children grouped on the basis of handedness.

The second main column of Table 8 presents the standard deviations in months for the subject ages of the two groups, and the differences between the standard deviations. In each subject the left-handed group shows somewhat greater variability than does the right-handed group.

The third main column of Table 8 relates the means and the standard deviations in terms of the constant V. Although most of the differences between the two handedness groups are small, there is a tendency for the left-handed group to show a somewhat greater variation than the right-handed group. In nine of the twelve subject ages the V.'s for the left-handed group exceed those for the right-handed group. At the same time, in the case of only three of the ages—those for sentence meaning, science, and language—do the differences between the V's amount to more than three months. In general, it seems safe to conclude that the left-handed group of children who were studied tends to vary somewhat more widely in school achievement than does the right-handed group with whom they were compared.

Summary of the Chapter

The Stanford Achievement Test was used to measure the proficiency in the various school subjects of the two groups of children studied.

No reliable differences were found between the school achievement of the left-handed group and that of the right-handed group.

There is a suggestion that the left-handed group is slightly more variable in school achievement than is the right-handed group.

CHAPTER VI

HANDEDNESS AND PHYSICAL STATUS

It might be thought, *a priori*, that hand preference would have some unique relations with other physical traits of an individual. The purpose of this chapter is not to search out a large number of very detailed bodily differences between right- and left-handed children but rather to compare the two groups along the broad lines that are commonly used in practical educational procedure. The main bases of comparison have been, therefore, weight, height, and hand strength.

Handedness and Height

Each child in the two groups was weighed and was measured for height. In all cases heavy outer clothing and shoes were removed. The weight was taken to the nearest pound and the height to the nearest inch. The means, standard deviations, and

TABLE 9

Weight and Height of Left-Handed Group and Right-Handed Mates

Group	Height			Weight		
	Mean	S.D.	V.	Mean	S.D.	V.
Left-handed.....	56.52	4.28	7.40	85.88	19.45	22.65
Right-handed.....	56.59	3.72	6.57	89.72	25.35	28.25
Difference	.07	.56	.83	3.84	5.90	5.60

coefficients of variation were computed for each of the measures. These are presented in Table 9. It will be observed that there is no difference between the mean heights of the two handedness groups. The standard deviations and the coefficients of variation

for the left-handed group are slightly larger than the same measures for the right-handed group. In general, then, except for a very slight difference in variation within the groups, the left-handed children and the right-handed children show no divergence in height.

Handedness and Weight

Table 9 also presents the general facts concerning the weights of the two groups of children. The means indicate that the average child of the right-handed group is 3.84 pounds heavier than is the average child of the left-handed group. The probable error of this difference, however, is 2.66, which makes the divergence in mean weight entirely unreliable.

The right-handed group shows a much wider range of weights, in terms of both standard deviation and coefficient of variation. The S. D. of the left-handed group has a probable error of 1.14, which gives it a 50-50 chance of ranging from 18.31 to 20.39. The S. D. of the right-handed group has a probable error of 1.5, which gives it a 50-50 chance of ranging from 23.85 to 26.85. There is, therefore, a fair degree of reliability in the difference between the S. D. of the two groups.

Handedness and Weight Standard

In order to compare the two handedness groups from another point of view and also to compare the two groups with children at large, the number of children in the group studied who are overweight, underweight, and of normal weight was computed. The standard used was the Baldwin-Wood Weight-Height-Age Tables. The scale provides separate standards for boys and for girls. The ages were taken to the nearest year. The number of children in the two groups falling under the three weight classifications are shown in Table 10. The table means that 23 left-handed boys were overweight and 20 left-handed girls were overweight, or a total of 43 left-handed children were overweight.

The differences between the two groups are small when thus expressed. The total left-handed group shows slightly fewer overweight children, slightly fewer underweight children, and slightly more children of normal weight. Each group has more than two-thirds of its members classified as overweight. This

number is doubtless somewhat higher than a practical nutrition worker would place it. A fair number of children were overweight only a pound or two, a fact which is usually ignored when other physical conditions are normal.

TABLE 10

NUMBER OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES WHO ARE OVERWEIGHT, UNDERWEIGHT, AND OF NORMAL WEIGHT

Weight Status	Left-Handed Group			Right-Handed Group		
	Boys	Girls	Total	Boys	Girls	Total
Overweight	23	20	43	25	20	45
Underweight	5	10	15	7	11	18
Normal weight ...	3	1	4	0	0	0
Total	31	31	62	32	31	63

The weight difference in the two groups of children studied which is suggested by the large divergence in S. D. found in Table 9 is revealed more clearly by a computation of the mean number of pounds overweight of the two groups. These data are presented in Table 11. The amount of overweight or underweight was found for each child by the use of the Baldwin-Wood

TABLE 11

AVERAGE NUMBER OF POUNDS OVERWEIGHT OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES

Boys			Girls			Total		
Left	Right	Diff.	Left	Right	Diff.	Left	Right	Diff.
5.2	10.3	5.1	6.2	9.7	3.5	5.7	10.0	4.3

Tables. The difference between the total overweight and the total underweight was computed for each group and these differences were divided by the respective number of cases in each of the two groups. The table means that the left-handed boys were

on the average 5.2 pounds overweight, the right-handed boys 10.3 pounds overweight, and the difference between these two averages was 5.1 pounds. The striking fact brought out by the table is that the right-handed group is very much more overweight than is the left-handed group. The right-handed boys are nearly twice as much overweight as the left-handed boys. The right-handed girls are about a third more overweight than the left-handed girls. No very satisfactory explanation of this apparent relation between hand preference and degree of overweightness suggests itself, although the fact of this relation is consistent with certain facts concerning strength of grip which will be discussed at once and with certain facts concerning play interests which will be referred to in a later chapter.

Hand Preference and Strength of Grip

In order to obtain a general index of bodily strength, the grip of each hand of each child in the two groups was measured. Three trials with the Smedley improved dynamometer were taken with each hand and the highest record was used as the final score. The means, standard deviations, and coefficients of variation were computed for each group of children for each

TABLE 12

Strength of Grip of Left-Handed Group and Right-Handed Mates

Group	Mean				S.D.		V.	
	Left Hand	Right Hand	Both Hands	Diff.	Left Hand	Right Hand	Left Hand	Right Hand
Left-handed.....	22.14	21.49	21.82	.65	6.27	6.18	28.31	28.75
Right-handed....	22.36	24.61	23.48	2.25	6.69	6.75	29.91	27.42
Difference	.22	3.12	1.66		.42	.57	1.60	1.33

hand. The results are presented in Table 12. The table means that the left-handed group of children made a mean score of 22.14 kilograms with the left hand, a mean score of 21.49 kilograms with the right hand, and a mean score of 21.82 kilograms with both hands and that the difference between the scores for the two hands was .65 kilograms.

The right-handed group shows a greater strength of grip for each hand and for the mean of the two hands than does the left-handed group. The difference for the left hands of the two groups is small numerically but is based on a comparison of the non-preferred hand of the right-handed group with the preferred hand of the left-handed group. The difference between the strength of the right hands of the two groups is 3.12 with a probable error of .74, which makes this difference statistically reliable.

The difference between the preferred hands of the two groups of children can be seen by comparing 22.14 for the left-handed group with 24.61 for the right-handed group. The probable errors of these two means are .51 and .55 respectively, which gives the means a certain degree of reliability. A smaller degree of reliability is found in the difference between the means for the non-preferred hands of the two groups—21.49 for the left-handed group and 22.36 for the right-handed group, with probable errors for the means of .50 and .54, respectively.

The mean for both hands of the left-handed group is 21.82 and for the right-handed group it is 23.48. The difference between these two means is 1.66, with a probable error of .75. This difference is, therefore, fairly reliable statistically.

The standard deviations and the coefficients of variation of the two groups do not show large differences.

There is a tendency, therefore, for the heavier children—the right-handed group—to show greater general bodily strength as measured in terms of kilograms of grip. This fact was clearly brought out by McHale [1] in her comparison of the strength of grip of overweight, underweight, and normal weight children. Unless the superiority of weight and strength shown by the right-handed group of children in the present study is a chance occurrence, the question still remains unanswered as to the reason for this difference.

Summary of the Chapter

There is no reliable difference between the average height and the average weight of the two groups of children being compared.

The right-handed group shows considerably larger variation

[1] McHale, K., *Comparative Psychology and Hygiene of the Over-Weight Child*, p. 28.

in weight and a larger average overweight than does the left-handed group.

The right-handed group shows superior hand strength on the average as compared with the left-handed group, although the margin of reliability is not large. The degree of variability in hand strength within the two groups is very similar.

CHAPTER VII

HANDEDNESS IN RELATION TO INTERESTS

Thus far in the investigation the effort has been made to indicate the degree of relation that exists between handedness and various school factors which are capable of measurement by fairly standardized instruments. In addition, it seems worth while to canvass the possibility of a connection between manual preference and certain less tangible school elements, such as interests, school adjustment, and general emotionality. It will be the purpose of this and the following chapter to present some data bearing on such relations as they are found in the groups of children being studied.

Method of Measuring Interests

The collection of the data which are presented in this and the following chapter was effected by the use of a three-page interest blank, which was filled out by each child in each of the two handedness groups. The items on the blank followed closely the interest blank used by Terman [1] in his study of genius children in California. The first page of the blank contained space for the child's name, school, and grade; space for answering two questions on school adjustment; a list of school subjects to be checked on the basis of preference; a list of general activities to be checked on the basis of preference. The second page contained a list of games to be checked on the basis of experience in playing them and preference for them. The third page was for listing experiences which caused the child to respond in an emotional way. Details of these various exercises will be given in connection with the discussion of the data which resulted from each.

With the exception of a small group of absentees, all the children filled out the blank at a single sitting of about an hour's length. Most of those who were absent were later assem-

[1] Terman, L. M., *Genetic Studies of Genius*, Vol. I, pp. 363-64; 377-78; 388.

bled and were asked to fill out the blank. Prior to the checking of each section of the blank, the directions for that section were read and explained to the children. On each section all children started and stopped work at the same time. Sufficient time was allowed for each section of the blank to permit each child to work practically as long as he wished.

General Interests

For the purpose of obtaining data concerning possible differences betweeen the general interests of the two groups of children being compared, the following exercise was used:

Below are several different kinds of things to do. On the line before each thing, put a figure (1, 2, 3, 4, or 5) to show how well you like to do that kind of thing.

Put a 1 if you LIKE IT VERY MUCH
Put a 2 if you LIKE IT FAIRLY WELL
Put a 3 if you NEITHER LIKE IT NOR DISLIKE IT
Put a 4 if you RATHER DISLIKE IT
Put a 5 if you DISLIKE IT VERY MUCH

..... Studying lessons
..... General reading (books, magazines, newspapers)
..... Practicing music, drawing, dancing
..... Playing games that require little physical exercise
..... Playing games that require lots of exercise
..... Playing with several other people
..... Playing with one other person
..... Playing alone
..... Going to parties, picnics, dances, club meetings
..... Using tools or working with apparatus and machinery
..... Sewing, cooking, knitting, housework
..... Being leader in a team or club and managing other people

A tabulation was made of the number of children from each of the two handedness groups who expressed each degree of preference for each type of activity. From these figures the mean degree of preference of each of the handedness groups for each activity was computed. The means were calculated by assigning the following numerical values to the five possible attitudes which could be expressed: *Like Very Much,* a value of +2; *Like Some,* a value of +1; *Neither Like nor Dislike,* a value of 0; *Dislike Some,* a value of —1; *Dislike Very Much,* a value of —2.

The details concerning the attitude of these two groups of

children toward these general types of activities are presented in Table 13. The table means that toward the activity of studying lessons 23 members of the left-handed group expressed the attitude of liking it very much (L—M in the table), 23 expressed the attitude of liking it somewhat (L—S in the table), 10 of neither liking it nor disliking it (N in the table), 2 of rather disliking it (D—S in the table), 8 of disliking it very much (D—M in the table); and that the mean attitude of the left-handed group was +.8, or somewhere between liking it fairly well and neither liking it nor disliking it. The rest of the table is to be similarly understood.

The striking general fact revealed by Table 13 is the very close agreement of the two handedness groups in their attitude of interest toward these types of activities. In terms of step intervals in attitude, no activity shows an interest difference of as much as .5. Most of the differences are much smaller than this. It seems clear, then, that in terms of general interests these children exhibit no differences which can be directly related to hand preference.

One further comment on the table may be made. Children of this age, whether left-handed or right-handed, tend, on the basis of these data, to express a rather distinctly positive attitude toward the things in which they engage. It will be noticed that more than half of the means are +1 or higher. Only in the case of playing alone do the means become negative. This case also contributes a little to the general reliability of this method by indicating that activities which are distinctly uninteresting to children are likely to be so characterized by them.

Sex differences in attitude of interest toward these general activities were computed for each of the handedness groups. As they follow very closely the data on the two groups as presented in Table 13, they will not be presented in detail. A few sex differences are marked enough to be worth brief mention. Toward the activity of practicing music the groups of boys—right-handed and left-handed—expressed mean attitudes of +.3 and +.5, respectively, while the groups of girls—right-handed and left-handed—expressed mean attitudes of +1.6 and +1.7, respectively. The boys were somewhat more averse to playing alone than were the girls. Both groups of boys were considerably more interested in tools and machinery than were the girls, and

TABLE 13

INTEREST ATTITUDE OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES TOWARD VARIOUS KINDS OF GENERAL ACTIVITIES

Activity	Pupil Group	Attitude					
		L-M	L-S	N	D-S	D-M	Mean
Studying lessons	Left	23	23	10	2	8	+ .8
	Right	25	22	13	0	3	+1.0
General reading	Left	49	13	2	0	3	+1.6
	Right	44	13	2	1	0	+1.7
Practicing music, etc.	Left	36	12	9	5	3	+1.1
	Right	27	20	5	6	3	+1.0
Mild games	Left	24	21	10	7	2	+ .9
	Right	18	20	13	3	4	+ .8
Strenuous games	Left	47	12	4	0	2	+1.6
	Right	46	7	5	1	1	+1.6
Playing with several people	Left	52	7	6	1	0	+1.7
	Right	41	12	5	1	0	+1.6
Playing with one person	Left	17	23	18	5	2	+ .7
	Right	19	24	6	4	7	+ .7
Playing alone	Left	5	9	11	10	29	− .8
	Right	7	9	12	13	18	− .4
Going to parties, etc.	Left	43	7	7	4	4	+1.2
	Right	38	9	6	3	3	+1.3
Use of tools, etc.	Left	26	13	9	3	8	+ .8
	Right	23	16	6	8	3	+ .7
Sewing, cooking, etc.	Left	27	2	9	1	23	+ .1
	Right	25	6	2	3	17	+ .4
Being leader in an organization	Left	40	9	5	4	7	+1.0
	Right	31	12	10	4	5	+1.0

both groups of boys were very much averse to such activities as cooking and sewing. The boys were somewhat less interested in going to parties than were the girls. It may be said, in general, that the differences between the boys and girls in their interest attitude toward these general activities are greater in most cases than the differences between the entire right-handed group and the entire left-handed group.

Interests in School Subjects

In order to obtain some evidence of the attitude of each of the handedness groups toward various school subjects, the following exercise was used:

First, DRAW A LINE right THROUGH each subject you have NEVER STUDIED.

1. Next put a figure 1 on the dotted line before each subject that you LIKE VERY MUCH.
2. Put a 2 before each subject that you LIKE FAIRLY WELL.
3. Put a 3 before each subject that you NEITHER LIKE NOR DISLIKE.
4. Put a 4 before each subject that you RATHER DISLIKE
5. Put a 5 before each subject that you DISLIKE VERY MUCH.

.....Drawing (freehand)	.....Arithmetic
.....Painting	
.....Modeling	.....Geography
.....Music (playing an instrument)	.....General Science
	.....Nature Study
.....Music (singing)	.....Physiology
.....Citizenship	.....Hygiene
.....History	.....Cooking
.....Written composition	.....Sewing
.....Oral composition	.....Shopwork
.....Dramatizing	.....Mechanical drawing
.....Grammar	.....Folk dancing
..... Literature	.....Games and sports
.....Reading	.....Physical training

The number of children in each of the handedness groups who expressed each degree of preference for each subject was computed. From these data the mean degree of preference of each handedness group for each subject was computed. The comparison of the attitude of the two groups toward the various school subjects is presented in Table 14. The table means that for the subject of drawing, 39 left-handed children expressed

the attitude of liking it very much (L—M), 12 an attitude of liking it fairly well or somewhat (L—S), 3 an attitude of neither liking it nor disliking it (N), none an attitude of rather disliking it or disliking it somewhat (D—S), and 2 an attitude of disliking it very much (D—M), and that the mean attitude of the group toward drawing was +1.5.

As was the case in the comparison of handedness groups in terms of general interests, the data of Table 14 show strikingly small differences between the groups in attitude of interest toward the various school subjects. In a group of subjects involving manual operations—drawing, painting, modeling, instrumental music, written composition, shopwork—in which it might be expected that differences would appear, the two groups show but little divergence in interest. In cooking, sewing, and mechanical drawing the left-handed group expressed a considerably more negative attitude than did the right-handed group. In the subjects involving general physical activity—folk dancing, games and sports, and physical training—significant differences are lacking. On the basis of the evidence presented in Table 14 it must be concluded that children, when they are grouped in terms of manual preference, do not differ very markedly in interest shown toward various school subjects.

An analysis of sex differences in interest shown toward school subjects was also made for the two handedness groups. As was the case for attitude toward general activities, the differences were very small and they need not be reported in detail. In the case of a few subjects sex differences were found which were large enough to suggest a certain degree of reliability. Boys showed considerably less interest in both instrumental and vocal music than did girls. Boys as a group showed slightly less interest in such formal subjects as written composition and reading than did girls as a group. Boys showed slightly more interest in nature study and physiology than did girls. In the industrial subjects the preferences followed the well-known lines —the boys preferred shopwork and the girls preferred cooking and sewing. As was the case in the comparison of the handedness groups on the basis of general interests, the sex differences in attitude toward the various school subjects are larger for the children studied than are the differences on the basis of a handedness grouping.

TABLE 14

ATTITUDE OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES TOWARD VARIOUS SCHOOL SUBJECTS

Subject	Pupil Group	Attitude					
		L-M	L-S	N	D-S	D-M	Mean
Drawing	Left	39	12	3	0	2	+1.5
	Right	37	13	0	2	1	+1.6
Painting	Left	31	8	2	1	0	+1.6
	Right	24	10	1	2	0	+1.5
Modeling	Left	10	5	2	0	0	+1.5
	Right	7	6	0	0	0	+1.5
Music (instrumental)	Left	16	5	4	2	2	+1.0
	Right	17	7	3	1	2	+1.2
Music (vocal)	Left	26	16	8	0	5	+1.1
	Right	17	15	10	5	3	+ .7
Citizenship	Left	17	13	6	0	1	+1.2
	Right	18	8	5	0	0	+1.4
History	Left	25	17	6	1	2	+1.2
	Right	28	12	8	2	0	+1.3
Written composition	Left	22	20	11	2	2	+1.0
	Right	22	20	7	2	5	+ .9
Oral composition	Left	17	20	8	2	3	+ .9
	Right	18	18	5	6	3	+ .8
Dramatizing	Left	6	6	6	0	2	+ .7
	Right	8	3	5	1	0	+1.0
Grammar	Left	17	21	7	0	2	+1.0
	Right	11	19	10	2	1	+ .9
Literature	Left	10	9	6	1	2	+ .9
	Right	6	9	3	2	1	+ .8
Reading	Left	31	18	7	1	1	+1.3
	Right	30	16	7	0	1	+1.3

TABLE 14 (*Continued*)

Subject	Pupil Group	Attitude					
		L-M	L-S	N	D-S	D-M	Mean
Arithmetic	Left	29	22	8	2	0	+1.3
	Right	23	23	7	1	4	+1.0
Geography	Left	30	19	7	2	0	+1.3
	Right	33	16	4	1	2	+1.4
General science	Left	8	5	1	1	2	+ .9
	Right	6	5	2	2	0	+ .9
Nature study	Left	21	12	4	0	1	+1.4
	Right	20	14	6	0	0	+1.4
Physiology	Left	4	3	2	1	0	+1.0
	Right	3	2	2	1	1	+ .6
Hygiene	Left	13	14	9	1	0	+1.0
	Right	8	14	6	0	2	+ .9
Cooking	Left	14	2	1	0	5	+ .9
	Right	15	1	0	0	0	+1.9
Sewing	Left	19	9	1	2	6	+ .9
	Right	22	5	1	0	0	+1.8
Shopwork	Left	16	1	1	0	0	+1.8
	Right	12	1	1	1	0	+1.6
Mechanical drawing	Left	5	6	4	1	0	+ .9
	Right	4	3	1	0	0	+1.4
Folk dancing	Left	18	9	2	0	2	+1.3
	Right	13	5	0	0	0	+1.7
Games and sports	Left	44	10	1	0	0	+1.8
	Right	37	7	1	0	0	+1.8
Physical training	Left	38	13	5	0	1	+1.5
	Right	33	11	8	0	2	+1.4

Play Interests

It might be expected that groups of children differing in hand preference would exhibit some degree of divergence in the number and type of games which they engaged in. In order to obtain some data bearing on this question each child of the two groups was asked to carry out the following exercise:

First put ONE CROSS, x, on the line before each thing you HAVE EVER DONE OR PLAYED.

Next, put TWO CROSSES, xx, before each thing you LIKE TO DO OR PLAY

.....Roll hoops	.....Play tag	.....Play with dolls
.....Play jackstones	.....Ring around the rosy	.....Play "dress up"
.....Spin tops		.....Play house
.....Play jackstraws	.....London Bridge	.....Play store
.....Walk on stilts	.....Farmer in the dell	.....Play school
.....Fly kites	.....Hide and seek	.....Simon says thumbs up
.....Bow and arrow	.....Hopscotch	.....Dominoes
.....Coast or toboggan	.....Drop the handkerchief	.....Crokinole
		.....Parchesi
.....Ride bicycle	.....Blindfold	.....Tiddledy-winks
.....Skate	.....Post office	.....Cat and mouse
.....Ski	.....Red rover	.....Backgammon
.....Hike	.....Puss in corner	.....Authors
.....Do garden work	.....Pom pom pull away	.....Snap
.....Dance	.....Backman	.....Guessing games
.....Shoot	.....Marbles	.....Cards
.....Fish	.....Duck on rock	.....History cards
.....Swim	.....Follow the leader	.....Geography cards
.....Ride horseback	.....Anty over	.....Charades
.....Row a boat	.....Prisoner's base	.....Word building
.....Do plain sewing	.....Snap the whip	.....Solve puzzles
.....Cook a meal	.....Tug of war	.....Checkers
.....Do fancy work	.....Poly poly	.....Chess
.....Use tools	.....Jump the rope	.....Pool or billards
.....Use machinery	.....Leap frog	
.....Fox and hounds	.....Wrestling	.....Boxing
.....Fox and geese	.....Baseball	.....Tennis
.....Shinny	.....Racing and jumping	.....Volleyball
.....Croquet	.....Handball	.....Basketball
.....Bowling	.....Soccer	.....Football

General Play Activity

It was thought that the two handedness groups might differ in the number of games which they had played or preferred to play. In order to obtain some measure of such a difference, the number of games played and the number preferred by each child in the two groups were tabulated and the means and standard deviations were computed. This comparison is presented in Table 15. The table means that in number of games they had actually played, the left-handed boys showed a mean of 34.01 games and a standard deviation of 14.10 games; in games which they liked or preferred they showed a mean of 24.92 games, with a standard deviation of 16.60 games.

TABLE 15

Number of Games Played and Number Preferred by Left-Handed Group and Right-Handed Mates

Pupil Group	Number of Games			
	Played		Preferred	
	Mean	S. D.	Mean	S. D.
Left boys	34.01	14.10	24.92	16.60
Right boys	28.29	17.15	17.35	13.30
Left girls	32.65	15.45	17.95	13.70
Right girls	30.38	12.90	17.80	15.55
All lefts	33.33	14.85	21.44	15.70
All rights	29.34	15.15	17.58	14.45

The column in the table for games "played" shows that on the average the left-handed groups exceed the right-handed groups in number of games played. This holds for both sexes and for the groups as a whole. The right-handed boys and the right-handed group as a whole are somewhat more variable in number of games played than are the left-handed boys and the left-handed group as a whole. The left-handed girls are slightly more variable than the right-handed girls in number of games played.

The column for games "preferred" shows that the left-handed boys exceed the right-handed boys in average number of games; that the numbers for the two groups of girls are practically the same; that the total left-handed group prefers a somewhat larger number of games than does the total right-handed group. In games preferred the left-handed boys and the entire left-handed group show larger standard deviations than do the right-handed boys and the entire right-handed group. The right-handed girls are somewhat more variable in number of games preferred than are the left-handed girls. The trend of the deviations is exactly reversed in the case of the preferred games as compared with games which have been played; i. e., in the games "played" the right-handed boys vary more than do the left-handed boys, while in games "preferred" the left-handed boys vary more than the right-handed boys. The same reversal holds for the other two comparisons.

It appears, therefore, that on the basis of these data the left-handed group is somewhat more active in terms of number of play interests than is the right-handed group. The data on deviation in number of play interests do not permit of any very conclusive statement.

Types of Games Played

In order to obtain some evidence which might show differences in the types of games which were played and preferred by the two handedness groups, a tabulation was made of the number of children of each sex of each handedness group who played each of these games. This process produced a very large number of small items of information. Instead, therefore, of trying to compare the groups in terms of their interest in specific games, such as fox-and-geese or duck-on-rock, a classification was made of the entire list of games under ten large headings. The comparisons thus made possible between the types of games which the two groups play and prefer seem more significant than comparisons based on specific games.

The following is the list of large divisions used for the grouping with two illustrations of each main class:

1. Group games—active: hide-and-seek; leap-frog.
2. Group games—mildly active: London-Bridge; duck-on-rock.
3. Team games—active: football; basketball.

4. Pair games—active: boxing; wrestling.
5. Pair games—mildly active: marbles; jackstones.
6. Individual games—active: rowing; swimming.
7. Individual games—mildly active: fishing; bow-and-arrow.
8. Individual games—involving skill: sewing; using tools.
9. Dramatic games: play-house; play-school.
10. Intellectual games: checkers; authors.

With this tenfold classification as a basis, the number of games played by each sex of each handedness group and by the handedness groups as wholes are presented in Table 16. The table means that in the type of game characterized as "group" and "active" the left-handed boys had played on the average 8.2 games, the right-handed boys 6.5 games, the left-handed girls 8.1 games, the right-handed girls 7.5 games, the total left-handed group 8.2 games, and the total right-handed group 6.9 games.

The larger experience with games in terms of number played which was shown by the left-handed group as a whole in Table 15 is reflected in Table 16. Of the ten types of games in the latter table the left-handed group had played on the average

TABLE 16

EXPERIENCE OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES WITH VARIOUS TYPES OF GAMES

Type	Mean Number Played					
	Boys		Girls		Total	
	Left	Right	Left	Right	Left	Right
Group—active	8.2	6.5	8.1	7.5	8.2	6.9
Group—mild	5.0	3.5	6.1	5.7	5.6	4.6
Team	2.5	2.5	1.2	1.8	1.9	2.2
Pairs—active	2.1	2.2	1.0	1.3	1.6	1.8
Pairs—mild	2.0	1.5	1.6	1.4	1.8	1.4
Individual—active	2.4	2.1	2.0	1.5	2.2	1.8
Individual—mild	2.4	2.2	1.9	1.0	2.2	1.6
Individual—skills	1.4	1.1	1.8	1.6	1.9	1.4
Dramatic	1.6	1.1	3.8	3.3	2.7	2.2
Intellectual	4.8	4.1	5.1	5.0	4.9	4.6

a larger number than the right-handed group in eight of the divisions. The superiority of the left-handed group is seen in the following types: active group, mild group, mild pairs, active individual, mild individual, skillful individual, dramatic, intellectual. Only in two types do the right-handed children show a superiority in average number—in team games and in active pair games. In Table 16, as in Table 15, there is a suggestion that the left-handed children of this investigation are somewhat more interested in games than are the right-handed children. In the case of most of the types of games, however, the differences are so small as to be indicative of only a slight tendency.

Table 16 also presents data on sex differences in number of games played in each large class of games. Here again the differences are small and the same general trend as for the totals of the groups is seen.

One additional comment may be made concerning the totals in Table 16. The experience of most of these children has been primarily with three types of games—active group games, mild group games, and intellectual games. The fact that most of these children play either on the street or in their own home doubtless accounts for this rather sharp limitation in predominance of type. The street is more conducive to games of the large, active variety. The limited home space probably permits games which involve only a small amount of physical activity.

Games Preferred

In addition to indicating the games which they had actually played, the children were asked to check those which they liked best. Discrimination was thus made, in a rough way, between experience with various classes of games and preference for various types. The data bearing on the expressed preference of the two groups of children for the ten large classes of games are presented in Table 17. The table means that in active group games the left-handed boys expressed an average preference for 4.9 games, the right-handed boys for 3.1 games, the left-handed girls for 4.1 games, the right-handed girls for 4.1 games, the entire left-handed group for 4.5 games, the entire right-handed group for 3.6 games.

If reference is first made to the "total" column of the table, it will be seen that, as was the case of games played, the left-

handed group prefers more games in the majority of the large classes. In each of the ten types, with the exception of mild group games and dramatic games, the left-handed group exceeds the right-handed group in the average number which they prefer. On the whole, then, although the differences are small, there

TABLE 17

PREFERENCE OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES FOR VARIOUS TYPES OF GAMES

Type	Mean Number Preferred					
	Boys		Girls		Total	
	Left	Right	Left	Right	Left	Right
Group—active	4.9	3.1	4.1	4.1	4.5	3.6
Group—mild	1.3	1.2	1.8	1.8	1.6	1.5
Team	2.3	1.7	1.2	1.2	1.8	1.4
Pairs—active	1.7	1.0	1.1	1.1	1.4	1.0
Pairs—mild	1.1	.8	1.2	.9	1.5	.9
Individual—active	3.0	2.5	2.2	1.8	2.6	2.2
Individual—mild	2.5	1.2	1.2	1.4	1.9	1.3
Individual—skills	1.2	.6	1.1	1.1	1.1	.8
Dramatic	.4	.2	1.0	1.5	.7	.9
Intellectual	3.4	2.7	2.7	2.8	3.1	2.7

is a tendency for the left-handed group to prefer more games of each type than do the members of the right-handed group. There is also a tendency of each of the groups to *prefer* active group games and games of the intellectual types. This is similar to the tendency to *play* games of these types, which was indicated in Table 16.

Table 17 also presents sex differences in terms of types of games preferred. The left- and right-handed girls show very little divergence in types of games which they like. The left-handed boys, on the contrary, exceed the right-handed boys in each class of games. In only two cases, however, does the difference average as much as one game. These two cases are active group games and mild individual games.

Summary of the Chapter

Hand preference does not seem to be closely related to the general interests of children.

The interest of children in the various school subjects seems to be slightly but not significantly affected by their hand preference.

Of the two handedness groups under consideration the left-handed group plays and prefers a somewhat larger number of games than does the right-handed group.

The left-handed group tends to play and to prefer group games somewhat more than does the right-handed group.

Both groups of children play and prefer group and intellectual types of games rather than others.

CHAPTER VIII

SCHOOL ADJUSTMENT AND GENERAL EMOTIONALITY

That children differ in completeness of adjustment to the school organization is a fact of common observation. That children differ widely in the type of emotional response which they make to various school situations is rapidly becoming recognized. The purpose of this chapter is to indicate in a general way the strength of these two factors in the groups of children being investigated and to appraise any connection which they may have with hand preference.

School Adjustment

A single reliable index of school adjustment is not easy to find. In the present case the measure used is undoubtedly a rather rough one. It consisted merely of asking the child to answer either "yes" or "no" to the following question, which was part of the interest blank already referred to:

"Do you wear a P. S. 210 Effort and Conduct button?"

The policy of the school is to award this emblem at the end of each month to each child whose record in conduct and effort has been satisfactory. The child has the privilege of wearing the button as long as his adjustment to the school is expressed in acceptable conduct and effort. The presence or absence of the button is an indication, in terms of the teacher's judgment, of the extent to which the child has made this adjustment.

The percentage of children who wear and of those who do not wear the button was computed for each sex of each of the handedness groups. These data are presented in Table 18. The table means that 27.3 per cent of the left-handed boys wear the button, that 37.5 per cent of the right-handed boys wear it, and so on. The column headed "Total Group" shows that a somewhat larger percentage of the left-handed group than of the right-handed group made this form of adjustment to the school

situation. While the difference is not large, it does seem to indicate that the left-handed group as a whole is not unadjusted so far as wearing this button indicates adjustment.

Table 18 differentiates also between boys and girls in terms of school adjustment. The right-handed boys show a fair degree of superiority in the percentage wearing the button and the left-handed girls show a rather large superiority.

TABLE 18

PERCENTAGE OF LEFT-HANDED GROUP AND RIGHT-HANDED MATES WEARING THE "EFFORT AND CONDUCT" BUTTON

Adjustment Condition	Percentage					
	Boys		Girls		Total Group	
	Left	Right	Left	Right	Left	Right
Wearing button	27.3	37.5	54.6	33.3	40.9	35.4
Not wearing button	72.7	62.5	45.5	66.7	59.1	64.6

It must be concluded that, as measured by the rather crude method used here, the two groups of children show no difference in school adjustment which could be considered reliable. Within the sex groups, differences in adjustment as related to hand preference are considerable but do not tend in the same general direction. Thus, if any significance were attached to them, we should have to conclude that left-handedness in boys makes for lack of school adjustment, while the same hand preference in girls is a rather potent factor in effecting adjustment.

General Emotionality

A more exact comparison of the emotional characteristics of the two handedness groups than is to be reported would have been desirable. The measuring instruments now available, however, did not give much promise of revealing emotional differences in children of the age of those being investigated. It was therefore decided to make use of a kind of free association device as the means of locating possible differences. Accordingly, the following exercise was included in the Interest Blank.

First, write down all the things in school or at home that TROUBLE OR WORRY YOU. Write only ONE THING on each line.

Next, put ONE CROSS, like this, x, before each thing that troubles you MOST.

Since the response to the second part of the exercise was not made by the majority of the children, no report is made on that.

Classes of Worries

Each worry reported by each child was copied on a separate slip of paper to facilitate classification. After a great deal of experimentation a grouping of the worries was made under eight large types, as follows:

1. Worries concerning school subjects.
2. Worries concerning school standing.
3. Worries concerning relations with people in school.
4. Worries concerning out of school activities.
5. Worries concerning home relations.
6. Worries concerning personal appearance.
7. Worries concerning health problems.
8. Worries concerning moral problems.

The number of children reporting each specific worry was tabulated for each handedness group by sexes. These detailed data are presented in Table 19. The table means that arithmetic was reported as a worry by 9 left-handed boys, by 9 right-handed boys, by 10 left-handed girls, by 14 right-handed girls.

Except for the first two types of worries in the table, the numbers are too small to warrant placing much dependence upon the differences. In the first type—worries concerning school subjects—the left-handed boys exhibit a considerably larger total than do the right-handed boys. The difference for the two groups of girls in the same type of worry is small. The right-handed girls show a considerably larger number of worries concerning people in school and concerning home relations than do the left-handed girls.

In the worries listed under "school subjects" there is little evidence that specific subjects as the cause of children's worries are related to handedness. If this were the case, one might expect it to appear more clearly in those school activities which involve a large amount of manual precision. For the left-handed boys such subjects as penmanship and manual training receive almost

TABLE 19

WORRIES REPORTED BY LEFT-HANDED GROUP AND RIGHT-HANDED MATES

Worry	Number			
	Left-Handed Boy	Right-Handed Boy	Left-Handed Girl	Right-Handed Girl
1. School subjects				
Arithmetic	9	9	10	14
Grammar	8	2	2	5
Spelling	6	3	1	0
Geography	5	5	7	10
Reading	4	2	2	3
History	4	2	8	5
Composition	3	0	1	1
Penmanship	1	1	0	1
Nature study	1	0	0	0
Manual training	1	1	0	0
Physical training	0	1	0	0
Sewing	0	0	2	0
Drawing	0	0	0	1
Total	42	26	33	40
2. School standing				
Tests	5	5	12	13
Report cards	3	7	12	11
Promotion	5	3	5	11
Tardiness	2	1	2	1
Studying in school	1	2	5	0
Studying at home	1	4	9	4
Total	17	22	45	40
3. People in school				
Teachers	2	3	1	4
Pupils	3	5	0	3
Total	5	8	1	7
4. Outside activities				
Work	3	1	3	1
Play	3	3	0	0
Lessons: music, dancing	0	0	5	4
Total	6	4	8	5
5. Home relations				
Relatives	4	2	2	6
Home alone	1	2	0	0
Afraid of gas stove	1	0	0	0
Total	6	4	2	6

TABLE 19 (*Continued*)

Worry	Number			
	Left-Handed Boy	Right-Handed Boy	Left-Handed Girl	Right-Handed Girl
6. Personal appearance				
Cleanliness	2	0	0	0
Features and gait	2	1	0	0
Clothing	0	2	0	0
Total	4	3	0	0
7. Health				
Illness	3	3	1	1
Sleep	2	2	0	0
Dying	1	0	0	0
Food	0	1	0	0
Dental work	0	0	1	1
Accidents	0	0	1	0
Total	6	6	3	2
8. Moral problems				
Control temper	1	0	0	0
Be honest	1	0	0	0
Be good	1	0	1	2
Control talking	1	0	1	0
Fighting	0	2	0	0
Be careful	0	1	0	0
Do duty	0	0	0	2
Total	4	3	2	4
Total of all worries	90	76	94	104

no mention as causes of worry. The same statement applies to such activities as penmanship, physical training, and sewing for the left-handed girls.

The more academic school subjects—grammar, spelling, reading, history, composition—are mentioned somewhat more frequently by the left-handed boys as causes of worry than by the right-handed boys. Among the girls there are only small differences for the various subjects and there is no general trend which can be related to hand preference.

A few sex differences are worth consideration. Both groups of girls are very much more concerned about matters which are listed under "school standing" than are the two groups of boys.

Worries concerning tests, report cards, and promotion are mentioned about twice as frequently by the girls as by the boys. Studying at home and in school are also matters of greater concern to both groups of girls than they are to both groups of boys.

Under the heading "personal appearance," which includes cleanliness, features, clothing, the girls' groups report no worries. The boys mention a few worries under each of these items. Lack of "clothes-consciousness" on the part of both sexes may, perhaps, be partly explained by the semi-uniform which all the children in the school wear. This usually consists of a white shirt and dark trousers for the boys and a white blouse and dark skirt for the girls.

The totals for all kinds of worries show that the boys report 166 specific worries and the girls report 202 specific worries. The handedness groups are almost equal in the number of specific worries which they report—184 for the left-handed group and 180 for the right-handed group.

The relation of the worries for the two handedness groups can be seen somewhat more clearly in terms of the percentages of worries of each type for the two groups of children. These are presented in Table 20. The table means that in the class of worries designated as "school subjects" the left-handed group

TABLE 20

NUMBER AND PERCENTAGE OF VARIOUS CLASSES OF WORRIES REPORTED BY LEFT-HANDED GROUP AND RIGHT-HANDED MATES

Class of worry	Left-Handed Group		Right-Handed Group	
	No.	Per Cent	No.	Per Cent
1. School subjects	75	41.3	66	36.6
2. School standing	62	33.6	62	34.4
3. School people	6	3.1	15	8.3
4. Outside activities	14	7.6	9	5.0
5. Home relations	8	4.4	10	5.5
6. Personal appearance	4	2.2	3	1.6
7. Health	9	4.9	8	4.4
8. Moral problems	3	3.1	7	3.8
Total	184	100.0	180	100.0

of children reported 75 worries, or 41.3 per cent of their worries, while the right-handed group reported 66 worries in that class, or 36.6 of their worries. Except for the differences in percentages for "school subjects" and "school people," the divergence of the two groups in the types of things that worry them is extremely small.

The really significant thing about both Tables 19 and 20 is not the differences between the types of worries of the two groups of children but rather the types of things which both groups worry about. For the left-handed group 75 per cent of the worries and for the right-handed group 70 per cent of the worries concern school subjects and school standing. If to these two types of worries are added worries concerning school people, which includes teachers and pupils, the total of the three makes up nearly 80 per cent of the things which these children worry about. School problems loom very large in the emotional life of these children. The fact that the worries were reported just at the close of a school term probably tended to increase the completeness with which they filled the thinking of the children.

Summary of the Chapter

As measured by a somewhat crude instrument, the left-handed group seemed to be slightly better adjusted to the school situation than was the right-handed group.

Left-handed and right-handed groups of children differ very little with respect to the types of things that arouse emotions of worry.

CHAPTER IX

INTERFERENCE WITH NATURAL HANDEDNESS

Attention has already been called to the fact that parents and teachers have long considered left-handedness a handicap to an individual. This point of view has been especially pronounced with reference to the hand which the child was urged to use in his writing. It has been assumed that conformance to the right-handed writing habit has advantages which largely outweigh any temporary discomfort that the child may experience in making the transfer.

At the same time, arguments against any interference with the natural hand preference of the child have not been lacking. It has been urged that change of hand involves the disturbance of such a complex and ramifying set of nerve connections that the effects are never confined to a single form of behavior but tend to produce widespread changes of an undesirable sort. Thus it is argued that the cerebral areas which control the motor phases of speech can be so affected by a shift from the natural hand habit that various forms of speech disturbance are likely to result. Some reference has already been made to the studies bearing on this matter and the rather inconclusive results of the investigations have been noted.

The left-handed group used in this investigation contains a major fraction of children whose handwriting has been modified to conform to the more common right-handed pattern. It is the purpose of this chapter to present some data bearing on the characteristics of this "changed" group of left-handed children and to compare them with the "unchanged" left-handed group and with the right-handed group.

Distribution of Changed Group

The grade and sex distribution of the "changed" and the "unchanged" left-handed groups are presented in Table 21. It will be noticed that the "changed" group consists of a total of 43

children, or 63 per cent of the total left-handed group. In other words, only about one out of three of the members of the left-handed group under consideration has escaped interference with his natural hand preference. A total of 24 boys, or 69 per cent

TABLE 21

GRADE AND SEX DISTRIBUTION OF CHANGED LEFT-HANDED GROUP AND UNCHANGED LEFT-HANDED GROUP

Grade	Changed Group			Unchanged Group		
	Boys	Girls	Total	Boys	Girls	Total
Fourth	7	3	10	5	2	7
Fifth	5	5	10	2	4	6
Sixth	3	4	7	2	2	4
Seventh	9	7	16	2	6	8
Total	24	19	43	11	14	25

of the left-handed boys, have been changed; a total of 19 girls, or 58 per cent of the left-handed girls have been changed. The number of "changed" children in each grade follows very closely the general proportion of "changed" children in the entire left-handed group.

HISTORIES OF HAND CHANGE

It was possible to interview all except 2 of the 43 children in the "changed" left-handed group concerning the history of their manual transfer. In the great majority of cases the change was not left to chance but was systematically developed by parents and teachers. Of the 41 cases from which information was obtained, 21 children who naturally preferred the left hand had been trained at home to use the right hand. A group of 15 children had been changed after they entered school. A group of 5 had no recollection concerning the time or the manner of their shift from the left hand to the right hand. Thus 88 per cent of the group of 41 "changed" children from whom histories were available were trained by parents and teachers to use the right hand, especially in writing.

The transfer of the writing hand from left to right was often accomplished by the use of various kinds of punishments—especially at home. The following statements were made by different children concerning the history of the change in their own cases:

"Mother used to hit me on the knuckles to make me write with the right hand."

"Mother used to tie my left hand when I did home work."

"Mother taught me to write with the right hand before I went to school. She hit me on the hand when I used the left hand."

"Mother taught me to write with the right hand before I went to school. She slapped me when I used the left hand."

The following represent somewhat less severe forms of pressure but have the same motive:

"Mother urged me to use my right hand and helped me with my writing."

"Mother said it wasn't nice to write with the left hand."

"Mother held my left hand."

While the mother is most frequently mentioned by the children in connection with modification of the hand preference preceding entrance of school, father and older sisters are referred to by a number of children as having had a share in making the child right-handed in his writing.

The large majority of the children whose writing hand was changed after entering school went through this experience in the first grade. However, the transfer was made for one or more children in each grade from the first through the fourth. There has been, apparently, very wide difference in the age at which this change was made in this group of children.

Measurement of Speech Defects

The present study has dealt with the problem of the relation of changed writing hand to speech defects in much the same way that other characteristics of the two handedness groups have been compared. A simple speech test was prepared and given to the "changed" left-handed group, the "unchanged" left-handed group, and the right-handed mates of the "changed" left-handed group. A comparison of the speech defects of the three groups was then possible.

The test used to measure the number and type of defects consisted of the following eight sentences and twenty words:

1. I want to learn to speak correctly.
2. The hippopotamus is in the Hippodrome.
3. She sells seashells at the seashore.
4. Sam sang a sweet song on Sunday.
5. I wish you would wash this dish.
6. Hitch your horse to the birch-tree near the church.
7. Cheery Chickadee chirped and chattered.
8. The shepherd sheared the sheep in the shelter of the shed.

electricity	chew	frigid
hippodrome	Zuyder-Zee	scripture
narcissus	shelter	blister
hippopotamus	zeppelin	operate
chocolate	skeleton	butter
shuffle	dromedary	plenty
nautical	splutter	

Each child was examined alone by the speech teacher. The teacher pronounced the sentence or word, after which the child did the same. A check was placed in the proper space on the following blank to indicate the type of defects exhibited by each child.

Name.....Grade.....Date.....

Defects	*Sentences*	*Words*	*Total*
1. Stammering			
2. Stuttering			
3. Lingual Protrusion			
4. Lateral Emission			
5. Defective Phonation			

Description of Speech Defects

The classification of speech defects listed above is given by McCullough and Birmingham.[1] The following description is given by those authors of each of the five types of defects.

Stammering is a condition in which speech is apparently impossible for the moment. The tie-up of the vocal organs is more or less prolonged according to the individual case. The muscles of speech are rigid, while the oversupply of energy generated by this nervous tension often flows into other muscles, causing more or less violent accessory movements known as tics.

[1] McCullough, G. A. and Birmingham, A. V., *Correcting Speech Defects and Foreign Accent*, pp. 3-16.

On the other hand, the *stutterer* is able to produce speech. In fact, he seems to be afflicted with an overabundance of speech. Therefore it might almost be said that the stutterer cannot stop speaking, while the stammerer cannot begin. This repetition of the stutterer may be upon a letter, a syllable, a word, or a phrase; he may say p-p-please; or pa-pa-patience; or put-put-put it down; or may I-may I-may I have it? This is usually the step which precedes stammering.

This habit [*lingual protrusion*] most frequently begins during the period when the baby teeth are falling out. The almost irresistible desire to run the tongue over the gums where the teeth have left empty spaces leads to an habitual talking with that same forward position of the tongue. But lack of front teeth does not really prevent one from sounding the sibilants perfectly. Lisping is just a careless habit in the placing of the tongue.

Lateral emission, though also a defect dealing with sibilants, must be treated differently. Here we find that the tongue is buckled up instead of being pushed forward as in ordinary lisping. The center of the tongue being raised or even held against the roof of the mouth, the air must be emitted at the sides. A movement or tic of the palate may also accompany the production of sibilants and help cause that peculiarly disagreeable bubbling sound known as lateral emission lisping.

These cases [*defective phonation*] are largely a result of "baby talk," a deplorable habit which unfortunately is encouraged by many parents.

Various physical defects, according to the authors, may accompany and contribute to the poor quality of the speech. Some of the commoner of these are: tongue-tie, stoppage of nasal passages, cleft palate.

Hand Transfer and Speech Defects

A tabulation was made of the number of children in each of the three groups—"unchanged" left-handed group, "changed" left-handed group, and right-handed mates of "changed" left-handed group—who had no speech defects and of those who had some speech defect. These data are presented in Table 22. The table means that in the "unchanged" left-handed group 6 boys showed no speech defects, 11 girls showed no defects, a total of 17 "unchanged" left-handed children showed no defects; that 73.9 per cent of the "unchanged" left-handed group showed no defect and that the probable error of this percentage was 6.17. The percentages for the three handedness groups in "no defect" and "some defect" give a clearer picture of the difference between the three groups than do the numbers of children. It will be seen that the "unchanged" left-handed group and the right-handed group show approximately 25 per cent of defect each.

TABLE 22

SPEECH DEFECTS OF UNCHANGED LEFT-HANDED GROUP, CHANGED LEFT-HANDED GROUP, AND RIGHT-HANDED MATES OF CHANGED LEFT-HANDED GROUP

Speech Condition	Unchanged Left-Handed Group				
	Boys	Girls	Total	Per Cent	P.E. of Per Cent
No defect	6	11	17	73.9	6.17
Some defect	3	3	6	26.1	6.17
Total	9	14	23	100.0	

Speech Condition	Changed Left-Handed Group				
	Boys	Girls	Total	Per Cent	P.E. of Per Cent
No defect	14	13	27	62.8	4.97
Some defect	10	6	16	37.2	4.97
Total	24	19	43	100.0	

Speech Condition	Right-Handed Group				
	Boys	Girls	Total	Per Cent	P.E. of Per Cent
No defect	15	17	32	74.4	4.48
Some defect	8	3	11	25.6	4.48
Total	23	20	43	100.0	

Difference in per cent of "No defect" of "unchanged" left-handed group and "changed" left-handed group = 11.1 ± 7.78.

Difference in per cent of "No defect" of right-handed group and "changed" left-handed group = 11.6 ± 6.69.

Difference in per cent of "Some defect" of "unchanged" left-handed group and "changed" left-handed group = 11.1 ± 7.78.

Difference in per cent of "Some defect" of right-handed group and "changed" left-handed group = 11.6 ± 6.69.

Of the "changed" left-handed group, on the contrary, 37 per cent of the children have some speech defect.

In a recent study [2] of stuttering children it was found that the experimental group of stutterers made speech errors in 19 per cent of the total of sounds pronounced, while the control group of non-stutterers made 16 per cent of errors. These percentages are not strictly comparable to those presented in Table 22. They do, however, indicate a larger percentage of speech disorders in school populations than is commonly believed to exist and do corroborate, in a general way, the findings of the present investigation.

The "changed" left-handed group has been further compared with the "unchanged" left-handed group and with the right-handed group in terms of the difference in percentage of "no defect" and "some defect." These differences with their measures of reliability are given beneath Table 22. None of the differences is large enough in comparison with its probable error to be thoroughly reliable, although there is a fair suggestion that the "changed" left-handed group tends to show more speech defects than the "unchanged" left-handed group or the right-handed group.

Although the two left-handed groups do not show a highly reliable difference in percentage of speech defects, it may be conjectured that the "changed" left-handed group exhibited a larger degree of speech defect shortly after their hand behavior was interfered with. The defect which the group now shows may, therefore, be thought of as the end of the stage of recovery from whatever disturbance the hand change may have caused. This interpretation is supported by the results of the surveys of speech defects among school children which were carried out by Root [3] and Blanton. [4] Both of these investigators found that the percentage of children showing speech defects declined gradually from the first to the eighth grade. Elimination from school may account, obviously, for a part of this falling off in percentage of defects. It would seem profitable, in any case, to pursue the study of speech defects in their relation to handedness among children in the first three grades of the school.

[2] McDowell, E. D., *Educational and Emotional Adjustments of Stuttering Children*, p. 44.

[3] Root, A. R., "A Survey of Speech Defectives in the Public Schools of South Dakota," *Elementary School Journal*, Vol. 7 (1926), pp. 531-41.

[4] Blanton, S., "A Survey of Speech Defects," *Journal of Educational Psychology*, Vol. 7 (1916), pp. 381-92.

Hand Transfer and Types of Speech Defects

For the purpose of discovering, if possible, some causative factor which might account for the larger number of speech disturbances found among the "changed" left-handed group, analysis of the types of speech defects exhibited by the three handedness groups was undertaken. The frequency of occurrence of each type of defect among the three groups of children is presented in Table 23. The table means that 2 individuals in the "unchanged" left-handed group or 33.33 per cent of the children showing speech defects in that group exhibited the defect of stuttering; that 7 individuals in the "changed" left-handed group or 43.75 per cent of the children showing speech defects in that group exhibited the defect of stuttering. The remainder of the table is to be similarly interpreted.

In terms of similarity of origin, the five types of defects presented in the table fall into two groups. In the first group may

TABLE 23

Frequency of Occurrence of Each Type of Speech Defect in Unchanged Left-Handed Group, Changed Left-Handed Group and Right-Handed Mates of Changed Left-Handed Group

Speech Defect	Unchanged Group		Changed Group		Right-Handed Group		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Stuttering	2	33.33	7	43.75	5	45.45	14	42.42
Stammering	1	16.67	3	18.75	1	9.09	5	15.15
Lingual protrusion	2	33.33	3	18.75	4	36.36	9	27.27
Lateral emission	0	0.00	2	12.50	1	9.09	3	9.08
Defective phonation	1	16.67	1	6.25	0	0.00	2	6.06
Total	6	100.00	16	100.00	11	100.00	33	100.00

be included stuttering and stammering, which together contributed somewhat more than 57 per cent of the total number. The second group would consist of the three remaining types of defects: namely, lingual protusion, lateral emission, and defective phonation. This group of defects constituted somewhat more

than 42 per cent of the cases of speech abnormality found among the children being studied.

The description of lingual protrusion, lateral emission, and defective phonation, which was given earlier in the chapter, seems to indicate that this group of defects is mainly due to temporary or permanent abnormalities of mouth structure. If this causative explanation is sound, no close relation would appear to exist between these three types of defects and change of the writing hand. There remains, then, the first group of defects —stuttering and stammering—as the possible result of change of the writing hand. An appraisal will be made of the influence of hand change on these two types of speech defects.

Stuttering and Stammering in Relation to Hand Change

Table 23 shows that stuttering and stammering make up 50 per cent of the speech defects of the "unchanged" left-handed group, 62.5 per cent of the speech defects of the "changed" left-handed group and 54.54 per cent of the speech defects of the right-handed group. The "changed" group thus exhibits 12.5 per cent more cases of stuttering and stammering than does the "unchanged" group and nearly 7 per cent more cases than does the right-handed group. While these percentage differences are based on too few cases to have high reliability, they are consistent with the percentage differences presented in Table 22 and strengthen the suggestion that change of writing hand does have a bearing on speech defects.

In order to discover some cause for this apparent relation of hand change and stuttering and stammering, a brief survey will be made of the various theories which have been offered in explanation of these two types of defects. In general, there seems to be agreement that stuttering and stammering are caused by a *functional* disturbance rather than by an *organic* disorder. The search for the origin of the difficulty becomes, then, one of locating the factor or set of factors which produces the functional disturbance.

A cause of stuttering and stammering which is very commonly stressed by theorists is fear. Among those who give fear large emphasis in their explanations may be mentioned Fletcher,[5]

[5] Fletcher, J. M., "The Etiology of Stuttering," *Journal of the American Medical Association*, Vol. 66 (1916), pp. 1079-81.

Blanton,[6] Bluemel,[7] Scripture,[8] and Borden and Busse.[9] The meaning of fear as used by these investigators is variously defined. To Fletcher fear means an "anxiety," an "uneasiness," a "distrust of themselves." Blanton believes stuttering to be caused by the "fear of meeting the situations of life." To Bluemel the fear of the stutterer or the stammerer is similar in quality to the experience of stage-fright.

Imitation of the defective speech of adults or of other children has been offered by a number of writers as a potent cause of stuttering and stammering. In the judgment of Fletcher[10] imitation can be assigned as the cause of most cases of stuttering. Scripture[11] has observed that a stuttering parent nearly always has one or more stuttering children.

Some investigators believe that stuttering and stammering can be traced to some form of experience which the individual is attempting to suppress. Coriat[12] attributes stammering to the suppression of some experience of a sexual nature. Dunlap[13] suggests that the child's attempt to hide his knowledge of profane language in the presence of adults may be the first speech hesitation and the beginning of a case of stuttering.

A wide variety of other causal factors have been suggested to explain stuttering and stammering. The exhaustion following such diseases as typhoid fever, smallpox, measles has been offered by Bluemel[14] and others as the origin of the speech disturbance. Blanton and Blanton[15] express the view that any interruption or delay in the development of a motor coördination may produce a condition of uncertainty in the control of the muscles of speech. Such interruptions may be delay in walking or change of the writing hand. Reference was made in Chapter I to a number of other investigators who see in change of writing hand a possible cause of stuttering.

[6] Blanton, S., "Speech Defects in School Children," *Mental Hygiene*, Vol. 5 (1921), pp. 820-27.

[7] Bluemel, C. S., *Stammering and Cognate Defects of Speech*, p. 274.

[8] Scripture, E. W., *Stuttering, Lisping and Correction of the Speech of the Deaf*, p. 38.

[9] Borden, R. C., and Busse, A. C., *Speech Correction*, p. 281.

[10] Fletcher, J. M., *op. cit.*, p. 1081.

[11] Scripture, E. W., *op. cit.*, p. 7.

[12] Coriat, I. H., "Stammering as Psychoneurosis," *Journal of Abnormal Psychology*, Vol. 9 (1914), pp. 417-28.

[13] Dunlap, K., "The Stuttering Boy," *Journal of Abnormal Psychology*, Vol. 12 (1917), pp. 44-48.

[14] Bluemel, C. S., *op. cit.*, pp. 209-10.

[15] Blanton, M. G. and Blanton, S., *op. cit.*, p. 309.

It would seem reasonable to suppose that a number of the causes of stuttering and stammering which have been referred to would operate with equal force on the children of each of the three groups being compared—the "unchanged" left-handed, the "changed" left-handed, and the right-handed. Such common causes would be exhaustion due to diseases, imitation, suppressed experiences, and most forms of fears and anxieties. At the same time any form of emotional upset which could be traced to change of writing hand would become a differential factor which might account for the larger percentage of stuttering and stammering which has been found among the "changed" children.

In order to locate such a differential factor a further analysis was made of the histories of hand change which were referred to earlier in the chapter. The 41 histories of the "changed" group which were available were first divided into three groups on the basis of the place of hand change: (1) home, (2) school, and (3) unknown. Of the group which had been changed at home, 21 in number, 23.8 per cent showed the defect of stuttering or stammering. Of the group which had been changed in school, 15 in number, 33.3 per cent showed the same defect. Of the group which did not remember where the change had taken place, 5 in number, none showed the defect of stuttering or stammering. In short the children for whom change of hand had not been a serious enough experience to impress the location of the change on their minds did not exhibit the defect of stuttering or stammering. The evidence here is somewhat indirect in character but tends to support the theory of a relation between change of hand and these two forms of speech defect.

In order to obtain more direct evidence of a relation between the circumstances under which change of hand was effected, and speech defects, an analysis was made of the forms of pressure which had been used on the 21 children whose writing hand was changed at home. This group was divided into two classes: (1) those who reported any form of pressure or punishment in connection with hand change, and (2) those who reported no form of pressure in connection with the change. In the first group, consisting of 8 children, there was 37.5 per cent of stammering and stuttering. In the second group, consisting of 13 children, there was 15.4 per cent of stammering and stuttering. In other words the children who reported any form of pressure or punish-

ment in connection with their change of writing hand exhibited more than twice the percentage of stuttering and stammering as did the children who reported no pressure or punishment. While the numbers on which these percentages are based are small, the difference between the percentages is large enough to be suggestive of some relation.

The several elements which seem to be involved in the relation of change of hand to functional speech defects may now be brought together into a summary statement. Attention has already been called to the fact that a variety of causes has been offered by investigators in explanation of stammering and stuttering. This probably indicates that such disorders have a more complex origin than is apparent on the surface.

Since, in the case of the children being studied, the hand change was made either at home or in the first grade of school, the majority of the children were five or six years of age when the modification was going on. Since the hand preference might be expected to be moderately well fixed by that time, the change doubtless involved breaking a fairly well-formed habit. The reconditioning process would thus necessarily be continued over a rather long period of time.

At the time of the hand change most of these children were in the midst of the rapid development of speech habits. We might expect that the disturbance incident to the sudden and radical change of hand behavior would tend to unsettle other habits, such as those involved in language.

Further, the change of hand was accompanied in a number of cases by various forms of physical and verbal pressure which could easily give to the entire process an emotional element, such as fear or embarrassment. Since the common tendency of an affective experience is to produce widespread rather than local effects, the child's confidence in his control of language habits might be somewhat shaken by the change of hand habits.

The data which have been presented do not warrant the conclusion that change of the writing hand is the commonest cause of speech disorders. They do seem to justify the hypothesis that where other predisposing causes are present—such as exhaustion from illness, or anxieties—change of hand may provide just the additional burden to the child's unstable nervous system which will bring on some form of functional speech defect.

Change of Hand and Degree of Hand Dominance

It might be supposed that interference with hand preference, even to the extent of changing the writing from the left hand to the right, would cause a considerable disintegration in the dominance of the preferred hand. In order to appraise this possibility, the left-handed group was separated into the "changed" and the "unchanged" groups on the basis of the set of handedness tests which were described in Chapter III. The percentage of each of the two groups of children who passed the set of tests with each score was computed. The median score and the semi-interquartile range were also found. These data are presented

TABLE 24

Variation in Degree of Hand Dominance of Changed Left-Handed Group and Unchanged Left-Handed Group

Score		Changed Left-Handed Group		Unchanged Left-Handed Group	
Size	Per Cent of Tests	No.	Per Cent of Pupils	No.	Per Cent of Pupils
16	100.0	3	6.98	0	.0
15	93.7	1	2.33	0	.0
14	87.5	8	8.60	1	4.0
13	81.2	0	.0	1	4.0
12	75.0	8	18.60	7	28.0
11	68.7	3	6.98	1	4.0
10	62.5	10	23.26	5	20.0
9	56.2	2	4.65	2	8.0
8	50.0	5	11.63	5	20.0
7	43.7	0	.0	1	4.0
6	37.5	1	2.33	1	4.0
5	31.2	1	2.33	0	.0
4	25.0	0	.0	0	.0
3	18.7	0	.0	0	.0
2	12.5	1	2.33	1	4.0
Total		43	100.0	25	100.0
Median score		11.0		10.0	
Q of score		2.04		1.87	

in Table 24. The numbers in the first column represent the lower limits of the scores. The table means that a score of 16, which includes one hundred per cent of the tests, was made by 3 "changed" left-handed children, that these 3 left-handed children made up 6.98 per cent of the "changed" left-handed group. It will be seen that in terms of median score made on the set of tests, the "changed" group is more dominantly left-handed than is the "unchanged" group. The "changed" group is slightly more variable than is the "unchanged" group.

The comparisons presented in Table 25 show even more clearly the greater dominance of the left hand in the "changed" group as compared with the "unchanged" group. The table means

TABLE 25

PERCENTAGE OF CHANGED LEFT-HANDED GROUP AND UNCHANGED LEFT-HANDED GROUP WHO MADE SCORES WITHIN EACH QUARTILE OF THE TESTS

Score		Percentage of Group	
Quartile	Scores Included	Changed Left	Unchanged Left
75–100	12–16	46.51	36.00
50–74	8–11	46.51	52.00
25–49	4–7	4.65	8.00
0–24	0–3	2.33	4.00

that within the upper quartile of the total test scores which comprised those from 12 to 16 inclusive there were 46.51 per cent of the "changed" left-handed group and 36.00 of the "unchanged" left-handed group. It will be seen that 11 per cent more of the "changed" group than of the "unchanged" group passed 75-100 per cent of the tests. Again, 5 per cent more of the "unchanged" group than of the "changed" group passed 50-74 per cent of the tests. Finally, only 7 per cent of the "changed" group as compared with 12 per cent of the "unchanged" group passed fewer than 50 per cent of the tests.

On the basis of the above data on hand dominance, it seems safe to conclude that this "changed" left-handed group has not suffered any serious general hand disturbance as a result of the shift in the writing hand.

Change of Hand and Physical Strength

Strength of grip was used in Chapter VI as a general index of physical stamina. More narrowly it can be thought of as representing the relative muscular development of the two hands, considered apart from general bodily strength. The question easily suggests itself as to whether change of hand in writing would tend to accustom the "changed" left-handed children to using the right hand for other activities which among the "unchanged" left-handed children would be done with the left hand. If this were to happen, one might expect that the right hand of the "changed" left-handed child would show greater average strength than the right hand of the "unchanged" left-handed child. In order to test this hypothesis, means, standard deviations, and coefficients of variation for strength of grip were computed for the "changed" and "unchanged" left-handed groups separately. These data are presented in Table 26. It will be

TABLE 26

Strength of Grip of Changed Left-Handed Group and Unchanged Left-Handed Group

Group	Means		S.D.		V.	
	Left	Right	Left	Right	Left	Right
Changed	22.36	21.90	6.78	6.72	30.32	30.68
Unchanged	21.90	20.70	4.95	5.01	22.60	24.20
Difference	.46	1.2	1.83	1.71	7.72	6.48

seen that each of the hands of the "changed" group is slightly stronger than the corresponding hand of the "unchanged" group. The differences, however, are so small as to be suggestive of mere chance variations. The standard deviations and coefficients of variation are all considerably higher for the "changed" group than for the "unchanged" group. Whether this wider spread in hand strength within the "changed" group is due to the fact of their having been changed or is due to other causes, cannot be positively stated from the evidence here presented. In general, it seems safer to say that change of hand in writing has pro-

duced no reliable change in general bodily strength in so far as that is indicated by hand pressure.

Summary of the Chapter

This study offers only slight evidence of a relation between change of the writing hand and speech defects.

Change of writing hand does not appear to make the child less dominant in his preferred hand.

Change of writing hand appears to have little measurable effect on general physical strength.

CHAPTER X

EDUCATIONAL IMPLICATIONS OF HANDEDNESS

The preceding nine chapters have been devoted to a detailed comparison of two groups of school children. The groups were similar in chronological age, in sex, and in school grade. They differed in hand preference. With these three similarities and this one difference as a starting point, an attempt has been made to indicate the extent to which the two groups are related in other respects. Comparisons have been drawn between the two groups in respect to general intelligence, school achievement, interests, emotionality, physical status, and composition of hand behavior pattern. In addition, some attention has been given to the effects of interfering with natural handedness.

It is recognized that this small group of children, drawn from a single racial type in a large city, cannot provide an adequate basis for final conclusions concerning the significance of handedness. It is not the wish of the writer to make any far-reaching deductions from the body of data which have been presented. On the other hand, certain implications of the study appear to be clear enough to warrant giving them a tentative statement. The remainder of the chapter will be devoted to this task.

The Concept of Handedness.—Handedness is not a form of behavior which can be adequately described by a few general categories. There are, to be sure, certain types of activities which are likely to be found as the core of a great many individual handedness patterns. Most persons, for example, who belong to one broad type of handedness will tend to use the same hand for throwing, receiving, and reaching. They may differ widely in the remaining hand activities which compose their total manual pattern. It would seem wise, therefore, in dealing with school problems involving considerations of handedness, that educators expect considerable individual variation in manual behavior. Such variations may take the form of differences in direction of movement in drawing, in manner of using shop tools.

Handedness and Intelligence.—The data presented in this study offer no evidence of any sort to support a theory of relation between type of hand behavior and general intelligence. In dealing with questions of mental status, then, handedness is no better criterion to use than would be color of hair or shape of face. Intellectual differences are not related to manual variations.

Handedness and School Achievement.—Since the general correlation of intelligence and school achievement is known to be high, it might be expected that hand behavior would have about as close relation to ability in the school subjects as it has to mental ability. This, in fact, is the general conclusion which must be drawn from the data of this study. Broadly speaking, degree of ability in the school subjects seems not to be related to the hand behavior of the individual. There is the slightest suggestion that paragraph reading and arithmetical computation might be of higher quality among right-handed children as compared with left-handed individuals. With reference to the other school subjects, the data presented in this study offer no evidence of a relationship between achievement and hand pattern. In general, the practical school worker will want and need much more convincing proof of a relationship between handedness and school achievement than the present investigation offers before he will be moved to modify his procedure in the light of such a relation.

Handedness and Interests.—The nature of the interest which children display toward school activities has long been considered by educators to be an important element in the entire learning process. If two groups of children are found to differ significantly in the type and degree of their interests, some adequate explanation for such a variation is usually sought. The evidence presented in this study would exclude type of handedness as an element in such an explanation. Manual pattern appears to have little potency in determining the kinds of activities, either in school or outside of school, in which the average child is interested.

Handedness and Emotional Response.—There is relatively little objective evidence available concerning the characteristics and causes of emotional responses. Only in a rather gross and general way are we able to differentiate between forms of be-

havior that belong to this broad type. It is easy, therefore, for theorists to entertain almost any proposal as a possible explanation for some phase of emotion. Handedness could conceivably be used as well as any other type of explanation. The data presented in this study, although of a rather crude character, exclude the possibility of any close connection between handedness and that kind of emotional response to which the term "worry" is applied. Children vary, to be sure, in the things that they worry about, but such variations are not closely related to the type of hand behavior which they employ.

Handedness and Physical Status.—The general physical status of an individual is determined by a large number of factors. A few of the more obvious elements which contribute to his total bodily condition are his inherited type of physique, his childhood disease and accident history, his set of physical habits, his knowledge of principles of hygiene. A very rough measure of this complex combination of factors can be obtained by weighing, measuring the height, and taking a record of the general bodily strength of the individual. Of these three general indices, height exhibited no relation to types of handedness. Weight and general bodily strength, on the basis of the evidence of this study, appear to have a slight relation to handedness. The right-handed children are somewhat heavier and somewhat stronger than the left-handed children. Although the difference in strength for the two handedness groups stands the ordinary statistical test for the present, one need not be surprised to find that future studies do not show the same type of difference.

Interference with Handedness.—Probably the most mooted practical issue in relation to the problem of handedness is the question as to whether the naturally preferred hand, ought, in the interest of economy, to be interfered with. That this is being done in the case of approximately two-thirds of the left-handed children, we have already seen. The evidence which has been offered bearing on the effect of such a change has been shown to be rather inconclusive. The general dominance of the left hand seems not to be affected by the change. In fact such evidence as we have seems to point to a strengthening of its dominance. The data with reference to the relation of hand change to speech disturbance seem to point slightly in the positive direction. Children who have had their natural hand prefer-

ence interfered with appear to be somewhat more likely to exhibit speech defects than those who have not experienced such a change. In order to trace fully the relation between hand change and speech disorders, investigation of children younger than those used in the present study seems necessary.

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